DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-282

TO 31R2-2FRC15-1

RADIO SET AN/FRC-15

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

JUNE 1955

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 160-volt receiver plate circuit, or the 115-volt ac line connections

DON'T TAKE CHANCES!

EXTREMELY DANGEROUS VOLTAGES EXIST IN THE FOLLOWING UNITS:

Power Supply PP–804/U ..... 500-volt circuits
Radio Transmitter T–417/GR ..... 500-volt circuits

TECHNICAL MANUAL
No. 11–282
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DEPARTMENTS OF THE ARMY AND
THE AIR FORCE
WASHINGTON 25, D. C., *28 June 1955*

RADIO SET AN/FRC–15

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains the necessary information for the installation, operation, maintenance, and repair of Radio Set AN/FRC–15 (fig. 1).

b. Official nomenclature followed by (*) is used to indicate all models of the equipment covered in this manual. Thus, Electrical Equipment Cabinet CY–1221(*)/G represents Electrical Equipment Cabinets CY–1221/G and CY–1221A/G; Radio Set AN/VRC–6(*) represents Radio Sets AN/VRC–6, –6X, –6XX, –6Y, –6YY, and –6Z.

c. Forward comments on this publication direct to Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, N. J., ATTN: Standards Division.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army materiel and equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army); Navy Shipping Guide, Article 1850–4 (Navy); and AFR 71–4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700–45–5.

c. DD Form 535, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700–45–5.

d. DA Form 11–238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form (fig. 40).

e. DA Form 11–239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form (fig. 41).

f. Use other forms and records as authorized.

3. System Application

Radio Set AN/FRC–15 is one of several radio sets which are used for nontactical and tactical service. The frequency coverage of the radio set is 25 to 50 megacycles (mc) and constitutes the lowest frequency range of the series of companion equipments. Communication by means of Radio Set AN/FRC–15 will not be possible with any equipments other than those radio sets in the same frequency range classification. These sets consist of both fixed and mobile units which receive and transmit by means of omnidirectional antenna systems. The primary use of Radio Set AN/FRC–15 will be as a fixed station, and it will communicate with both fixed and mobile equipments in the same frequency range. Generally, the system compares with civilian very high frequency (vhf) installations which are used by police, fire fighting organizations, and public utilities. Very little attention is required by operating personnel; however, when the equipment is operated from a remote position, local start-stop must be used. Figure 2 illustrates a nontactical use of the radio set.

Section II. DESCRIPTION AND DATA

4. Purpose and Use

a. Radio Set AN/FRC–15 consists of an assembly of components designed for voice transmission and reception by means of frequency modulated (fm) signals at frequencies in the vhf range of 25 to 50 mc. The equipment is intended for fixed station operation with a power output of approximately 45 watts. The basic components of the

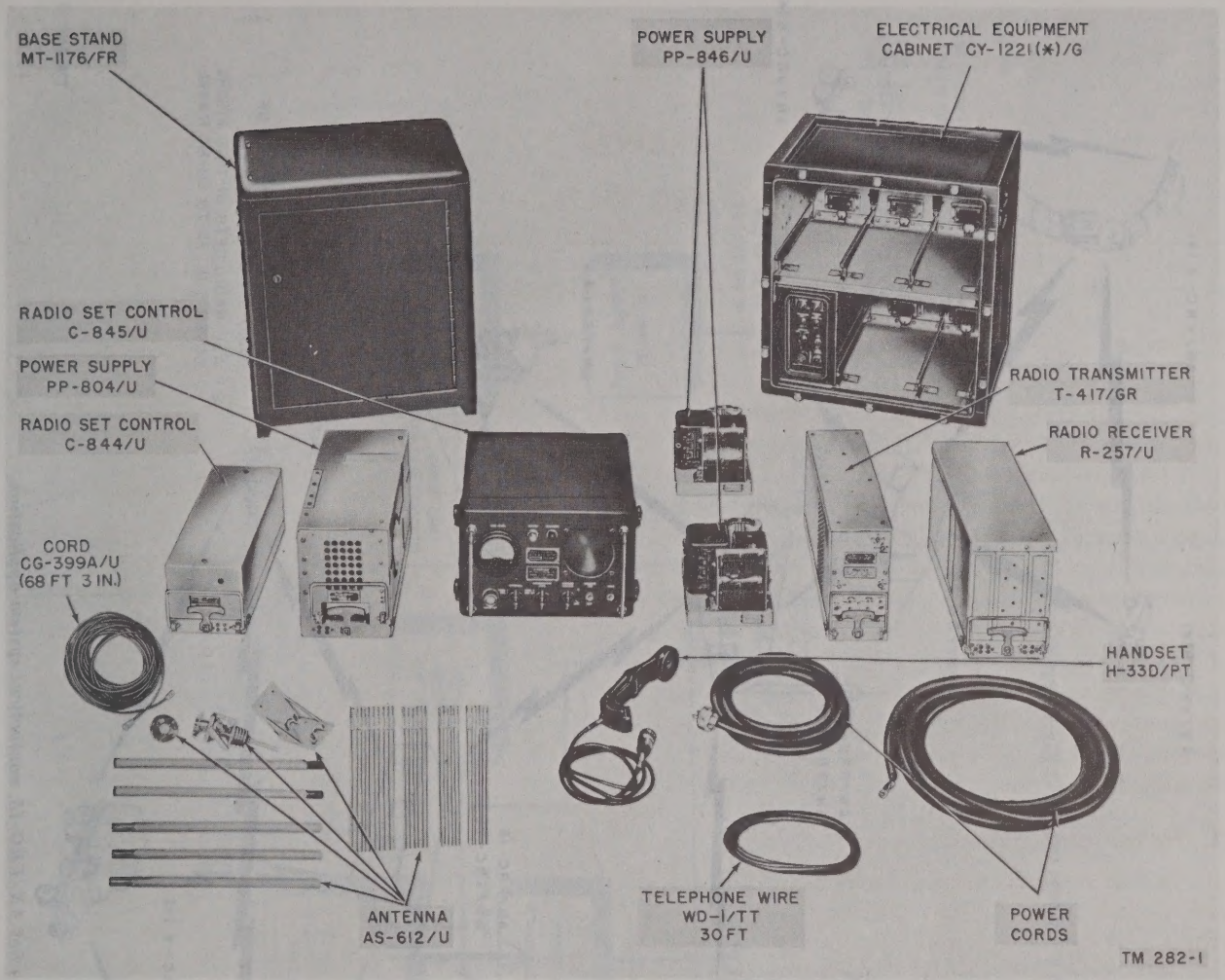


Figure 1. Radio Set AN/FRC–15.

radio set (fig. 1) are Radio Receiver R–257/U, Radio Transmitter T–417/GR, Power Supplies PP–846/U and PP–804/U, Radio Set Controls C–845/U and C–844/U, Electrical Equipment Cabinet CY–1221(*)/G, Base Stand MT–1176/FR, and the antenna system. Refer to the table of components (par. 13) for a complete listing of the components of the radio set and to paragraphs 5 through 10 for technical data.

b. Various combinations of associated components permit using Radio Set AN/FRC–15 in a number of different ways. Manipulation of one switch will enable the radio set to operate on either of two preset frequencies. This operation is accomplished either locally or at a remote control unit up to 10 miles away. Operation of the radio set is primarily push-to-talk (simplex). However, duplex operation can be effected by the use of two frequencies so that transmission and reception can occur simultaneously. In addition to operation between two points of communication, the radio set can be used as a relay (retransmission) station between two radio sets too widely spaced for direct communication.

c. After installation of the radio set at a suitable site (par. 29), it might become necessary to move the operating position to a remote point. The remote control unit supplied with the radio set will permit the operating position to be moved and set up as required by the existing situation. Controls are provided on the control unit to allow intercommunication between the fixed site of the radio set and the operating position, to effect frequency changes. Refer to figure 3 for the basic block diagram of the radio set.

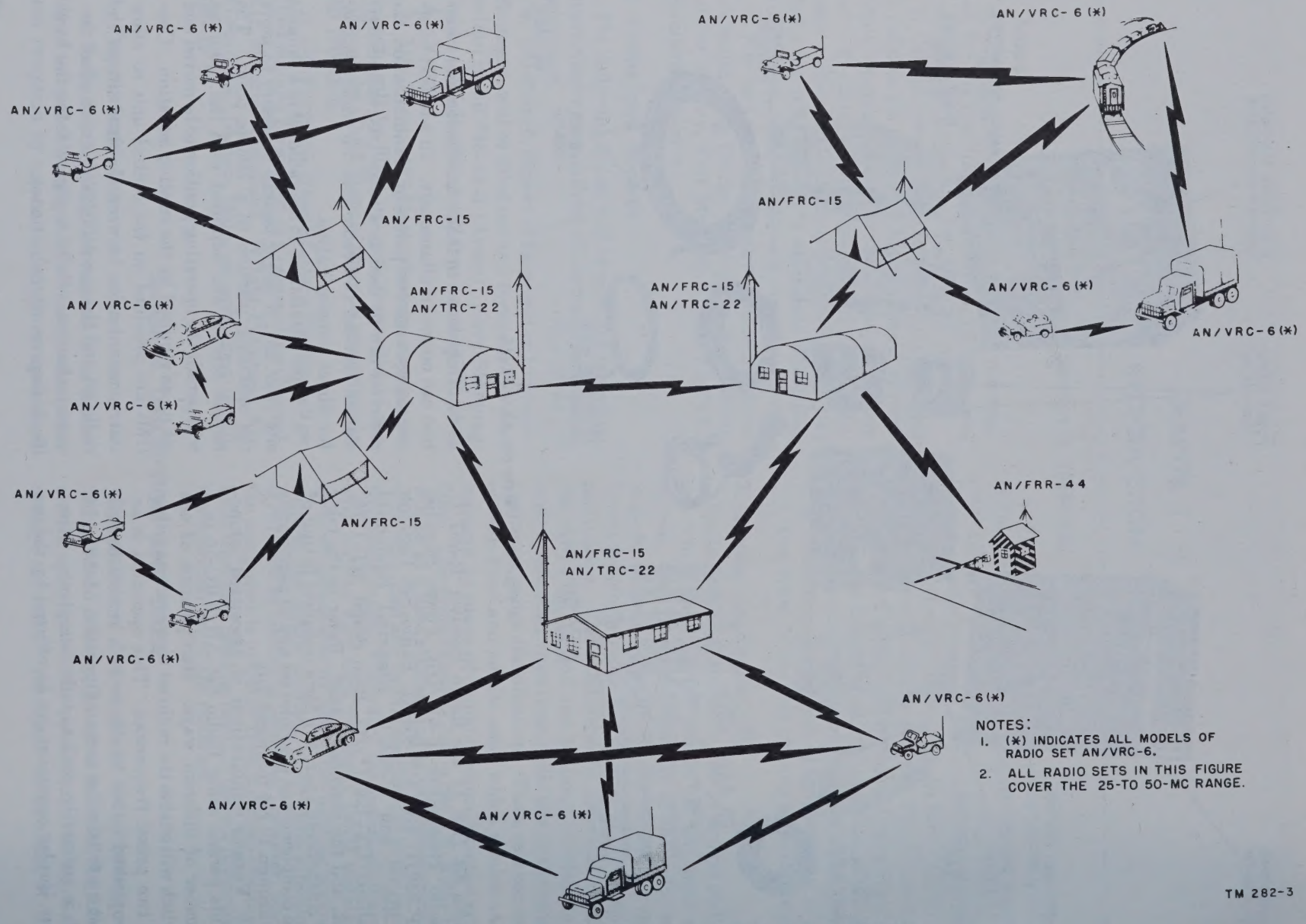


Figure 2. Radio Set AN/FRC–15, nontactical system application.

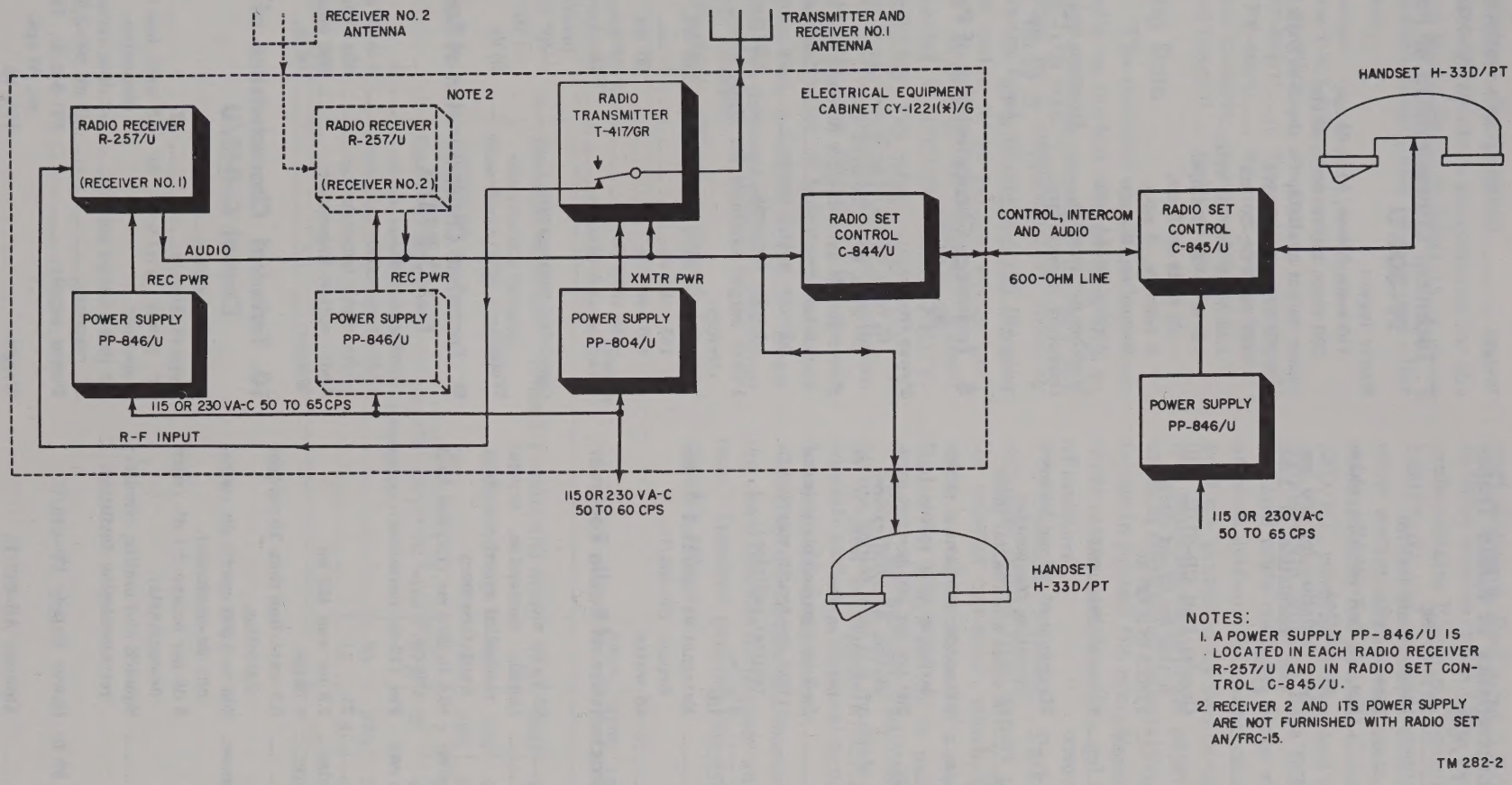


Figure 3. Radio Set AN/FRC–15, block diagram.

5. Technical Characteristics of Radio Transmitter T–417/GR

Frequency range	25 to 50 mc.
Transmitter type	Crystal-controlled fm.
Distance range	Line of sight.
Type of modulation	Fm, as derived from phase modulation.
Frequency deviation	15-kc deviation for 100 percent modulation at 1,000 cycles.
Type of transmission	Voice.
Crystals:	
Type	Crystal Unit CR–27/U, calibrated for 32 $\mu\mu$f circuit.
Frequency range	1,562.5 to 3,125 kc.
Multiplication factor in transmitter	16 on all frequencies.
Preset frequency operation	Maximum of .25 mc between operating frequencies.
Rf output impedance	50 ohms into coaxial cable.
Audio input:	
Carbon microphone	100 mv for 100 percent modulation at 1,000 cycles.
600-ohm line input	200 mv for 100 percent modulation at 1,000 cycles.
Spurious emission	Attenuated at least 70 db below carrier.
Antenna AS–612/U	Drooping ground plane (nominal one-fourth wavelength vertical radiator).
Weight, unmounted	8½ lb.
Number of tubes	13.
Power supply	External ac operated Power Supply PP–804/U.
Power output	45 watts.

6. Technical Characteristics of Radio Receiver R–257/U

Frequency range	25 to 50 mc.
Receiver type	Double conversion, crystal controlled superheterodyne, fixed frequency.
Crystal range (third overtone).	16.4 to 28.9 mc (Crystal Unit CR–32/U).
Type of signals which can be received.	Fm (15-kv deviation).
Number of tubes	21.
Intermediate frequencies	7.8 mc and 455 kc.
Audio output impedance	8 ohms.
Audio power output	0.5 watt, less than 10 percent distortion.
Audio frequency response	300 to 3,500 cps±1 db (without de-emphasis). 6 db per octave ±1 db (with de-emphasis).
Special features	Squelch and muting circuits; retransmission facilities.
Power supply:	
115 or 230 volts, 50 to 65 cps ac.	Power Supply PP–846/U.
Antenna	Antenna AS–612/U.
Weight	26-lb. (including Power Supply PP–846/U).

7. Technical Characteristics of Power Supply PP–804/U

Power input:
- 115 volts, 230 va, 50 to 65 cps.
- 230 volts, 230 va, 50 to 65 cps.

Power output available for the T–417/GR:
- 500 volts dc, 250 ma.
- 225 volts dc, 70 ma.
- 1.35 volts dc, 1.0 amp.
- 1.3 volts dc, .2 amps.
- −25 volts dc, 5 ma.
- 6 volts dc, .3 amp.
- 6 volts ac, .9 amp.
- 6 volts ac, 2.1 amp.

Weather and climate	Moisture and fungiproofed.
Operating temperature	−40° C. (−40° F.) to +65° C. (+149° F.).
Weight	40 lb.

8. Technical Characteristics of Power Supply PP–846/U

Power input:
- 115 volts, 46 va, 50 to 65 cps.
- 230 volts, 46 va, 50 to 65 cps.

Power output available for filament and heater circuits:

6.3-volt heaters	0.45 amp.
6.3-volt crystal heater	0.9 amp.
1.4-volt filament	1.25 amp.

Power output available for plate, screen grid, and bias circuits:

160 volts dc	15 ma.
155 volts dc	5 ma.
145 volts dc	50 ma.
−40 volts dc	0.5 ma.
Weather and climate	Moisture and fungiproofed.
Operating temperature	−40° C. (−40° F.) to +70° C. (+158° F.).
Weight	10 lb.

9. Technical Characteristics of Radio Set Control C–844/U

Number of relays	3.
Audio attenuation	0 to 30 db.
Audio input impedance	600 ohms.
Audio output impedance	600 ohms.
Weight	10 lb.

10. Technical Characteristics of Radio Set Control C–845/U

Number of tubes	3.
Type of signals	af.
Af power output at speaker.	0.5 watt, less than 10 percent distortion.
Af line voltage output	−2 dbm across 600-ohm line.
Af response	±2 db 300–3,500 cps.
Power supply	PP–846/U, 115- or 230-volt ac, 60 cps.
Weight	17½ lb.

11. Nomenclature Assignment

A list of the nomenclature assignments for the components of Radio Set AN/FRC–15 is given below. A common usage name is indicated after each component.

Nomenclature	*Common name*
Radio Transmitter T–417/GR_	Transmitter.
Radio Receiver R–257/U____	Receiver.
Power Supply PP–804/U_____	Transmitter power supply.
Power Supply PP–846/U____	Receiver power supply.
Radio Set Control C–844/U__	Radio set control.
Radio Set Control C–845/U___	Radio set control.

12. Packaging Data

a. General. The contents of all packages are stenciled directly on the box. A packing slip, in a moistureproof envelope, is stapled to each box and is protected by a supplementary covering patch. An orange band painted around the center of the box and a stripe painted across each end indicates packaging for export. Export packing is labeled PACKED WITH DEHYDRATING AGENT, DO NOT OPEN UNTIL READY FOR USE. An orange spot indicates that the box is part of a shipment; the specific box and the total number of boxes are indicated by a marking such as, 1/3, 2/3, and 3/3. Items may be packaged in a different manner, depending upon the supply channel.

b. Export Packing. When packaged for export shipment, Radio Set AN/FRC–15 is packed in three wooden crates (figs. 16, 17, and 18). One crate contains Electrical Equipment Cabinet CY–1221(*)/G and its components. Packed in another section of the same crate are the cords and cables, Radio Set Control C–845/U, Handset H–33D/PT, running spares, and the manuals. The second crate contains Base Stand MT–1176/FR. A third crate contains parts which make up the antenna system. The components packed for export are protected by two cartons between which is a moisture-vaporproof paper container. Pads made of corrugated material are placed in the container to protect the equipment from shock. The inner carton contains silica gel for the absorption of moisture.

c. Domestic Packing. Packing for domestic shipment differs from export packing mainly in the exterior container, which, for domestic shipment, is a carton instead of a wooden crate. When Radio Set AN/FRC–15 is packed for domestic shipment, the handset, radio set control, running spares, cables, and the manuals are packaged in a separate carton. The total number of cartons for domestic shipment is four.

d. Case Contents and Dimensions. The following chart lists the dimensions and contents of each case. Itemized packing lists are attached to each case for reference.

Type of packaging	Number of crates	Contents	Height (in.)	Width (in.)	Length (in.)	Volume (cu in.)	Unit weight (lb)
Domestic	4	Electrical Equipment Cabinet CY–1221(*)/G with components installed.	27⅞	22½	26¼	16, 464	196
		Base Stand MT–1176/FR	29	20⅛	23¾	13, 860	94
		Accessories	22¼	12¾	27⅜	7, 742	64
		Antenna	14	7	34	3, 332	30
Export	3	Electrical Equipment Cabinet CY–1221(*)/G with components installed and accessories.	27¾	22	47⅝₁₆	28, 844	317
		Base Stand MT–1176/FR	28	22⅞	26¼	15, 444	130
		Antenna	15	8	36	4, 320	30

13. Table of Components, Radio Set AN/FRC–15

Component	Dimensions of components					
	Required No.	Height (in.)	Depth (in.)	Width (in.)	Volume (cu in.)	Weight (lb)
Radio Receiver R–257/U	1	8½	14½	5¾	708	19
Power Supply PP–846/U	2	5⅛	6¼	7 1/16	226	10½
Radio Transmitter T–417/GR	1	8½	14½	4½	554	9
Power Supply PP–804/U	1	8⅝	7	14½	875	40
Radio Set Control C–845/U	1	8 7/16	13¾	13½	1564	17½
Radio Set Control C–844/U	1	8¾	14¾	5⅞	757	6½
Electrical Equipment Cabinet CY–1221(*)/G	1	21¼	16⅞	20½	7351	58
Base Stand MT–1176/FR	1	23½	17	21¾	7091	74
Antenna AS–612/U	1	11½	41	5¼	2368	10
Handset H–33D/PT	1	2	2¼	7	31. 5	1 1/16
Kit, running spares	1	4	6	6	144	10
Cables, set	1	15¼	12¼	7½	1450	31
TM 11–282	2	8½	½	11	46. 7	1
TM 11–5071	2	8½	½	11	46. 7	1
TM 11–804	2	8½	½	11	46. 7	1
TM 11–5072	2	8½	½	11	46. 7	1
TM 11–5078	4	8½	½	11	46. 7	1
Total						291 1/16

Notes.

1. Official parts list may call for the following added items:

Quartz Crystal Unit CR–27/U (transmitter)

Quartz Crystal Unit CR–32/U (receiver)

Crystals for this set must be furnished for the frequency specified by the user.

1 Tube, electron, type 5678

1 Receiver Subassembly MX–1547/G

2. The official parts list may differ from the table of components in the following manner:

1 Power Supply PP–846/U (a PP–846/U is packed with Radio Set Control C–845/U).

14. Description of Radio Transmitter T–417/GR

(fig. 4)

Radio Transmitter T–417/GR is a crystal-controlled fm transmitter, capable of operation in the vhf range of 25 to 50 mc. It contains 13 tubes and has a radio frequency (rf) output of approximately 45 watts. Dual frequency operation permits a choice of either of two preset frequencies.

a. The transmitter depends on associated components for power and operating controls. It is a plug-in type component which automatically completes external circuits when installed in the radio set. The connection is made by a multicontact single connector at the rear. The front panel of the transmitter contains the controls and test points necessary for determining plate current and for matching the antenna and transmission line. It also contains peaking controls for the driver and power output stages. A lock-in handle provides a means of removing the transmitter from the case when replacement, tuning, or repair is necessary.

b. For operation of the transmitter from either a 115- or 230-volt alternating current (ac) power source, a separate power supply must be used. Power Supply PP–804/U delivers correct filament and plate voltages for the transmitter. Refer to paragraph 16 for a description of this power supply.

c. The output of the transmitter is connected directly to the antenna transmission line. An antenna changeover relay is incorporated in the transmitter output circuit, which switches the antenna so that it can be used for reception when the transmitter is on standby. This relay also protects the receiver from damage during transmission.

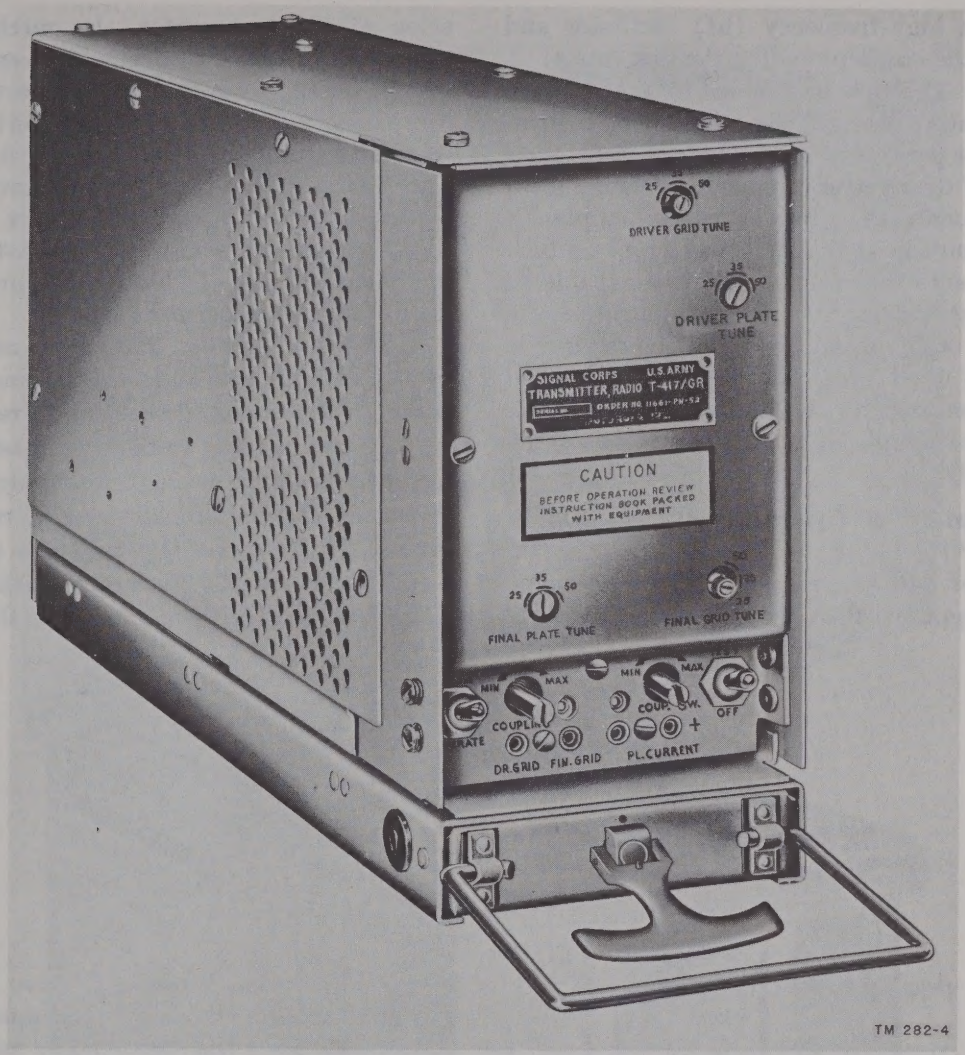


Figure 4. Radio Transmitter T–417/GR.

15. Description of Radio Receiver R–257/U (fig. 5)

a. Radio Receiver R–257/U is a 21-tube fm dual conversion superheterodyne receiver. It operates in the frequency range of 25 to 50 mc at a crystal-controlled, preset frequency. The two high frequency oscillators are crystal-controlled to provide maximum stability. The receiver is connected to the radio set by means of a single connector on the rear panel. Connection is automatic when the receiver is installed in Electrical Equipment Cabinet CY–1221(*)/G. Provision is made for checking receiver performance through test points located on the front panel. No controls are provided on the receiver panel because all control is performed at the electrical equipment cabinet or Radio Set Control C–845/U.

b. The receiver is made up of a base assembly with plug-in subassemblies for the various stages. The base has interconnecting wiring and jacks to complete the signal and current paths through the receiver. Each subassembly occupies a shielded compartment and is further shielded by a metal sleeve between the subassembly and compartment walls. This type of construction permits rapid servicing and a minimum of stock parts for replacement.

c. The receiver can be made to operate at a frequency different from its initial setup. To accomplish this, it is necessary to change a crystal

in the first high-frequency (hf) oscillator and realine all the stages preceding the first mixer.

Caution: This operation is not to be attempted by the operator. It must be performed by trained maintenance personnel.

d. One of the receiver compartments is designed to accommodate the receiver power supply (a separate component). This power supply, which is plugged into the receiver, must be capable of operating at the correct input voltage for the radio set in which it is installed. The receiver is designed to use Power Supply PP–846/U when operating as part of Radio Set AN/FRC–15. Refer to paragraph 18 for a description of the power supply.

16. Description of Power Supply PP–804/U (fig. 6)

a. General. Power Supply PP–804/U (TM 11–5072) supplies all power required for the operation of the transmitter. Its mechanical construction consists of a panel and chassis assembly. The power supply is held in a compartment of the equipment cabinet by a locking device which is controlled from the front panel. A blower located in the right side of the unit provides cooling air for the power supply components. When the power supply and transmitter are installed in the equipment cabinet, the blower also provides cooling air for the transmitter tubes.

b. Chassis Assembly. The chassis assembly consists of a base chassis and a side chassis. A transmitting relay socket, two selenium rectifiers, and brackets are fastened to the base chassis. Larger components, such as capacitors, blower, transformers, selenium rectifier, and reactors are mounted in the power supply on the side chassis. A changeover switch, which controls the input connections at the transformer primary, the fuses, and

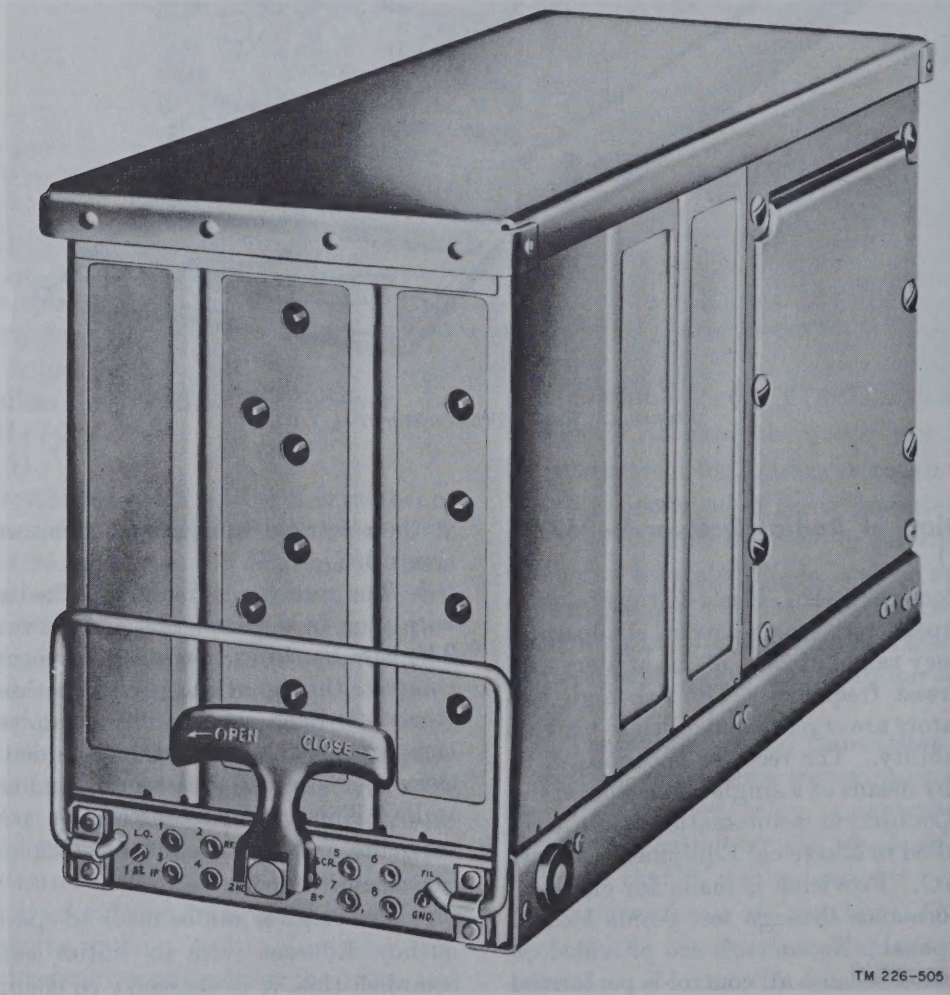


Figure 5. Radio Receiver R–257/U.

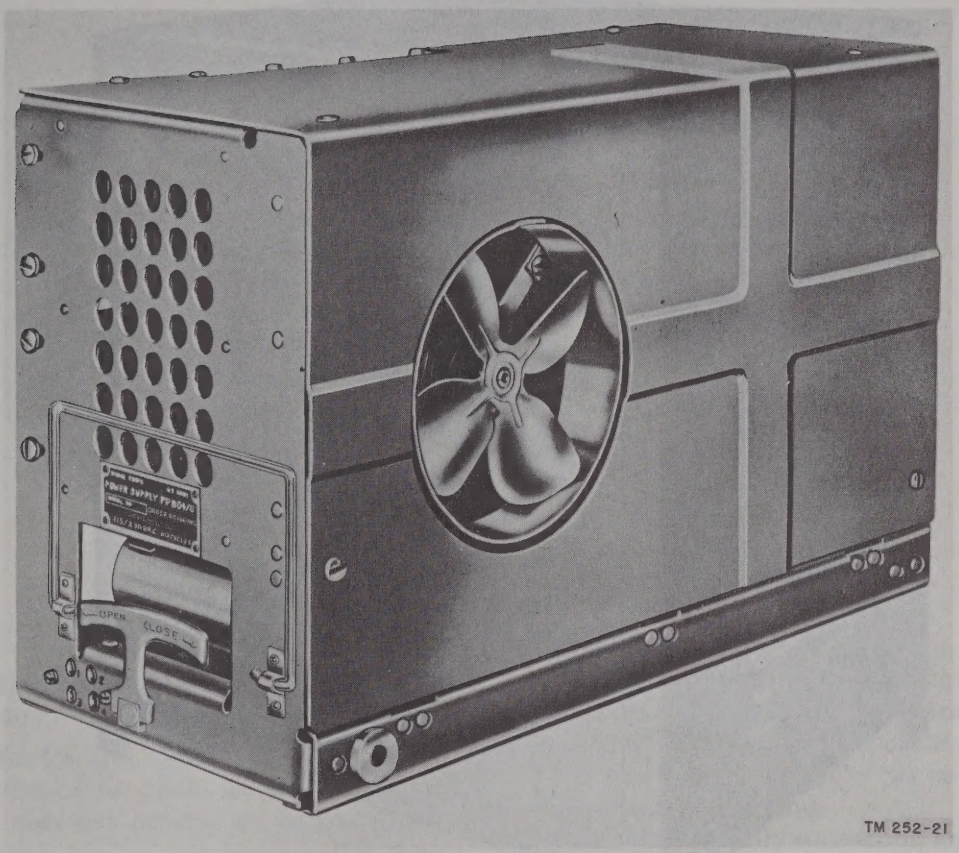


Figure 6. Power Supply PP–804/U.

other small parts, is mounted on the right side of the power supply. The unit is enclosed and protected on the bottom, top, and right side by two removable covers. Location of the fuses and the changeover switch is shown in figure 42.

17. Description of Base Stand MT–1176/FR (fig. 7)

Base Stand MT–1176/FR is used to mount Electrical Equipment Cabinet CY–1221(*)/G. Four studs, which protrude from the top cover of the stand, mate with four holes in Electrical Equipment Cabinet CY–1221(*)/G. This arrangement forms a secure mounting between the two components. The base stand has six louvers on each side for ventilation. Two doors are provided, one in the front and one in the rear, to gain access to the inside of the base stand. Two L-shaped brackets (not shown) are welded to the inside of the base stand. These brackets may be used to mount a test meter panel or speaker. The base stand may be used as a storage place for test equipment and miscellaneous items.

18. Description of Power Supply PP–846/U (fig. 8)

Power Supply PP–846/U (TM 11–5078) is designed to operate from a 230-volt or a 115-volt ac power source. Two units are supplied with the radio set; one for operation of Radio Receiver R–257/U and one for operation of Radio Set Control C–845/U. The power supply consists of a chassis on which are mounted the various parts necessary for transforming, rectifying, filtering, and regulating the voltages required by the receiver and the control unit. A compartment is provided for the power supply in the receiver base and in the control unit. The power supply chassis is fastened in place by six 10–32 bolts.

19. Description of Radio Set Control C–844/U (fig. 9)

Radio Set Control C–844/U is installed in Electrical Equipment Cabinet CY–1221(*)/G and permits remote control of the radio set when Radio Set Control C–845/U is used (par. 20). Radio Set Control C–844/U does not contain any

Figure 7. Base Stand MT–1176/FR.

tubes, but it does have relays to switch the transmitter frequency and select one or both receivers. (Only one receiver is supplied with the radio set, but space is provided in the cabinet for an extra receiver, if required.) Radio Set Control C–844/U has a single screw driver adjustment which is accessible through a hole in the front panel. This *line input* control adjusts the line level to the transmitter modulator. Both the top cover and bottom cover are removable for maintenance or repair. The front panel of the chassis has four test points. One of the test points is ground, two others check input and output audio voltages, while the fourth checks the voltage supplied to the control unit.

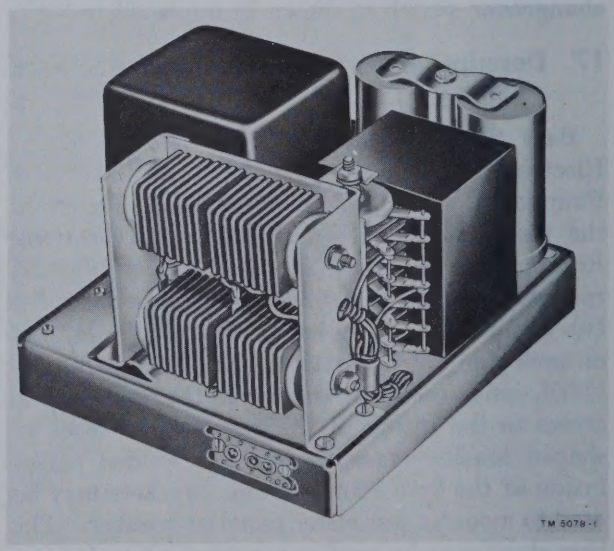


Figure 8. Power Supply PP–846/U.

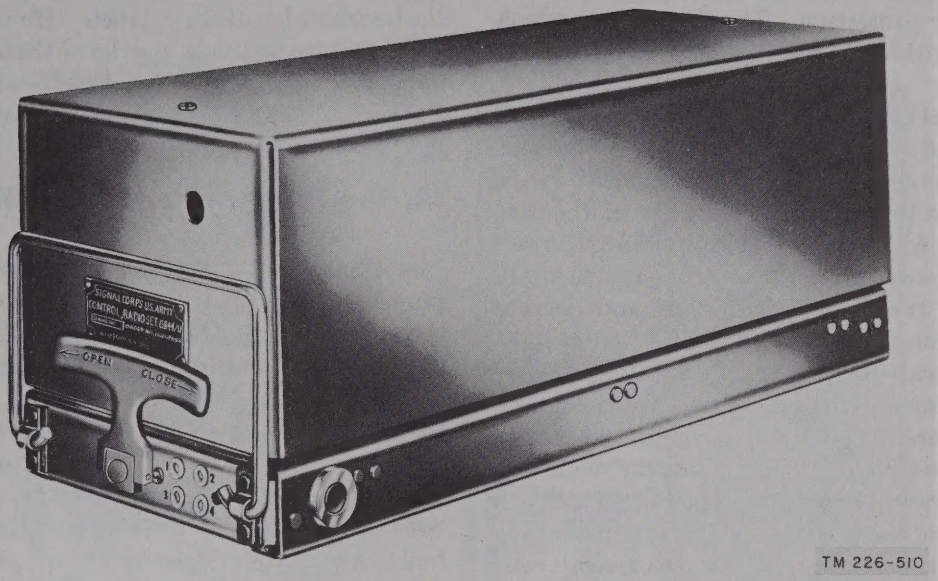


Figure 9. Radio Set Control C–844/U.

20. Description of Radio Set Control C–845/U

(fig. 10)

a. Radio Set Control C–845/U permits operation and control of the radio set from a remote location. It does not provide on-off control of the radio set; this function can be controlled from the local position only. The radio set control provides the following functions:

(1) Places the transmitter in operation.
(2) Selects one of the two preset transmitter frequencies.
(3) Monitors either or both receivers.
(4) Provides intercommunication to the radio set proper.
(5) Permits signaling with an audio tone.

b. The radio set control is housed in a metal cabinet of two-piece construction, with the front panel of the control fastened to the main portion by four trunk-type latches. Two handles, which are provided at the front panel for carrying, also serve to protect the front panel controls and instruments. Connection for the handset is made on the front panel, and the entrance hole for the interconnecting wires and power cable is at the rear. A line level meter is provided to adjust the signal from the handset microphone so that it will be strong enough to modulate the transmitter after passing through the interconnecting line. A speaker mounted on the front panel can be used to monitor the receiver. Two pilot lights indicate when the power is on and when the transmitter is in operation. The circuit incorporates a tone generator operating at 1,000 cycles per second (cps), which is used for signaling.

c. Generally, the only connection necessary for proper operation between the radio set and the control is a length of 600-ohm line. A separate power supply which is installed on the chassis of the control unit furnishes the proper filament and plate voltages for operation. Power Supply PP–846/U, which is the same type used for Radio Receiver R–257/U, is used for this purpose. Connection to the ac power source is made by means of a heavy duty rubber covered cable.

21. Description of Electrical Equipment Cabinet CY–1221(*)/G

(fig. 11)

a. Electrical Equipment Cabinet CY–1221(*) /G houses the receiver, transmitter, local control (Radio Set Control C–844/U), and associated power supplies of the radio set. These components are secured in their respective positions and are connected into the circuit with jacks positioned on the rear panel of the cabinet. These jacks engage the plugs on the components when they are inserted into the cabinet. The cabinet is made of aluminum and has two removable covers: one for the front and one for the rear.

When these covers are in place, they provide adequate weather protection. The components which are housed within the case are inserted from the front.

b. Terminal board connections, which make possible different types of operation, are located at the rear of the case. The front panel controls are located in the lower left hand corner of the case and are used for local operation of the radio set. Switches are provided on the control panel to apply power, select transmitter frequency, and operate the intercommunications system. A pilot light indicates when the power is on. Two screwdriver adjustments control the squelch sensitivity of the receivers. The handset connection also is located on the control panel. The rear panel has two connectors and two capped openings which are used to connect the radio set to the antenna or antennas and provide an outlet for the remote control wiring. Four handles are provided, two on either side of the case, to permit easy handling when moved.

c. The primary difference between Electrical Equipment Cabinet CY–1221/G and Electrical Equipment Cabinet CY–1221A/G is that all the A models have four spring-loaded bolts located on the bottom edge of the cabinet. However, some of the unlettered models also have these bolts. The bolts are not used when Electrical Equipment Cabinet CY–1221A/G is a part of Radio Set AN/FRC–15.

22. Description of Handset H–33D/PT

(fig. 12)

a. Handset H–33D/PT is a combination microphone and receiver with a push-to-talk switch and connecting cord. Microphone resistance is 40 ohms; receiver impedance is 300 ohms. The push-to-talk switch consists of two electrically independent single-pole, single-throw (SPST) switches. The cord is 6 feet long and is terminated in a 10-pin audio connector, which mates with the HANDSET connector on Radio Set Control C–845/U, or on Electrical Equipment Cabinet CY–1221(*)/G.

b. A handset holder is included with the equipment for holding the handset when it is not in use. The holder is packed with the spare parts and consists of a mounting bracket and clip assembly. The holder can be mounted on the radio set con-

Figure 10. Radio Set Control C–845/U.

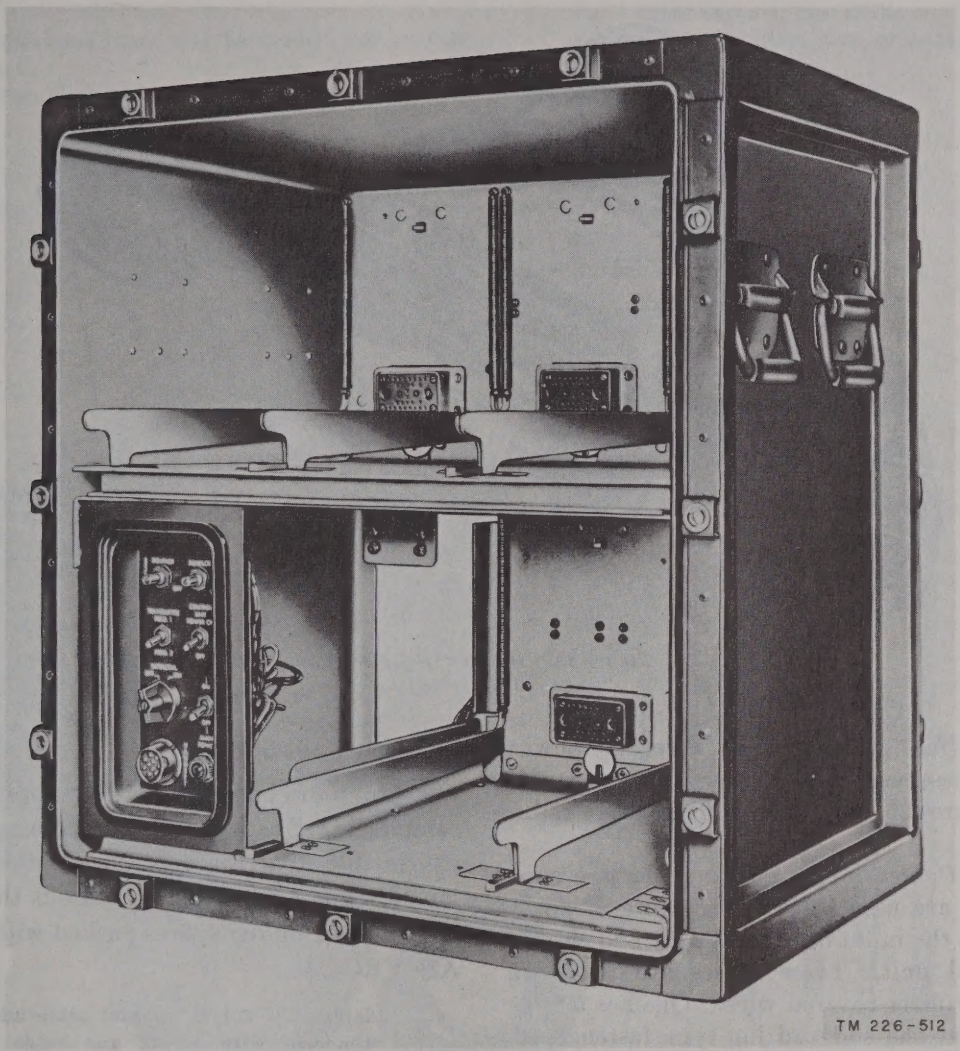


Figure 11. Electrical Equipment Cabinet CY–1221(*)/G.

trol or any other convenient location. See paragraph 29*b*(7) for assembly and installation details.

23. Description of Antenna AS–612/U
(fig. 13)

Antenna AS–612/U is a drooping ground plane quarter-wave vertical type, capable of operating in the 25 to 50 mc range. Radiation in all directions and at lower angles is obtained by using a vertical whip as the radiating element, and three similar elements spaced 120° apart as ground plane rods. The length of the whip element and the ground plane elements depends on the operating frequency; from 9 feet at 25 mc to 6 feet at 50 mc. Changing from one band to another is accomplished by the addition or removal of the radiating and ground plane sections. A right angle bracket, which holds the supporting structure, may be secured to a horizontal or vertical surface. Connection between the antenna and the transmitter is made by Radio Frequency Cable RG–8A/U, approximately 68 feet long. The exposed surfaces of the antenna have been chemically treated. This, along with a sturdy mechanical construction, will permit use during adverse weather conditions. For further information regarding mounting, refer to figure 25.

24. Cables

A set of cables is supplied with Radio Set AN/FRC–15 for interconnection of the units, an-

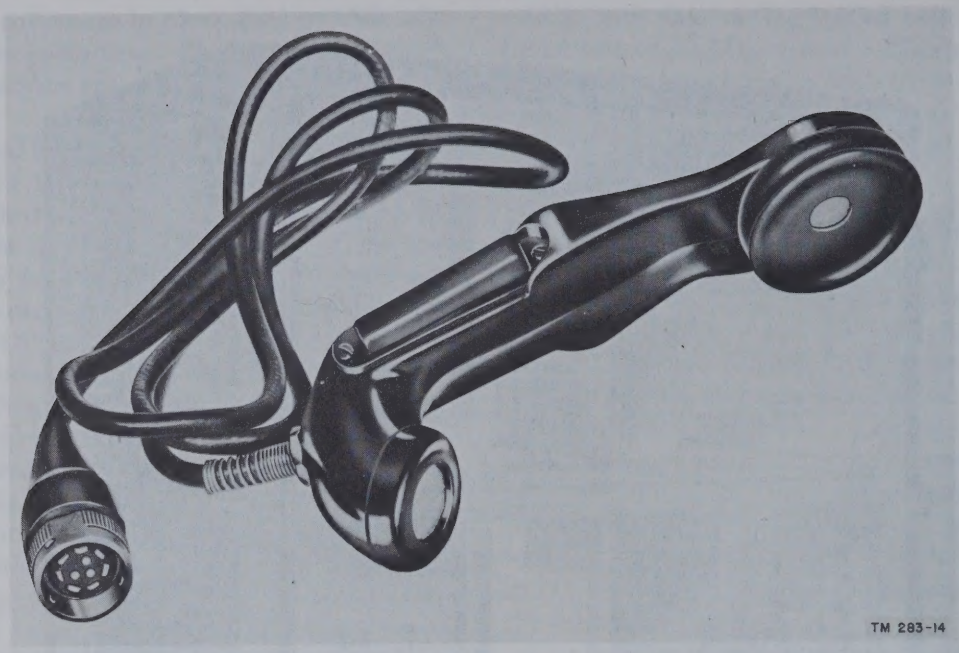


Figure 12. Handset H–33D/PT.

tenna, and for connection to external power sources. These cables are shown in figure 14. Refer to figures 26 and 27 for cabling of the radio set.

a. Power Cables. Two power cables are supplied which are used to bring ac power from a receptacle to the input of the radio set and the remote control unit. These cables are made of heavy duty rubber-covered wire. One has a two-prong plug at one end and lug-type fasteners at the other end, while the second has lug-type fasteners at one end only. A two-prong plug, for use with the power cable which connects to Electrical Equipment Cabinet CY–1221(*)/G, is furnished in a hardware bag as shown in figure 14. The cables, although similarly constructed, are of different lengths. A third cable interconnects Radio Set Control C–845/U with Electrical Equipment Cabinet CY-1221(*)/G. This cable consists of 30 feet of telephone wire.

b. Coaxial Cables. The radio set is connected to the antenna by a 68¼-foot length of Radio Frequency Cable RG–8A/U (Cord CG–399A/U). This cable has a Radio Frequency Plug UG–21B/U on one end and Plug PL–259 at the other end. The cable has a characteristic impedance of 50 ohms and is suitable for matching the receiver or transmitter to the antenna system supplied.

25. Running Spares

A group of running spares is supplied for each component. Spares are provided for all normally expendable items such as tubes, fuses, and pilot lamps. The following list contains the full complement of running spares packed with Radio Set AN/FRC–15:

1 Adapter UG–201/U, coaxial cable adapter, E1903, connects with E1902 and cable from J1904, mates with Radio Frequency Jack UG–22/U on one end and Radio Frequency Plug UG–88/U on the other end.
5 fuses, cartridge, 1½ amperes, 1¼ inches long, ¼-inch diameter.
5 fuses, cartridge, 2 amperes, 1¼ inches long, ¼-inch diameter.
5 fuses, cartridge, 3 amperes, 1¼ inches long, ¼-inch diameter.
1 headset clip, and mounting hardware.
2 lamps, neon, miniature bayonet base, 105 to 120 volts.
3 tubes, electron, type 1AD4.
1 tube, electron, type 2E26.
1 tube, electron, type 3B4.
1 tube, electron, type 6AK6.
1 tube, electron, type 12AU7.
2 tubes, electron, type 5672.
4 tubes, electron, type 5678.
1 tube, electron, type 5840.
1 tube, electron, type 6146.

Notes.

1. The following items may be deleted from the official parts list:

1 tube, electron, type 1AD4.

1 tube, electron, type 5672.

2. The following item may be added to the official parts list:

1 tube, electron, type 5678.

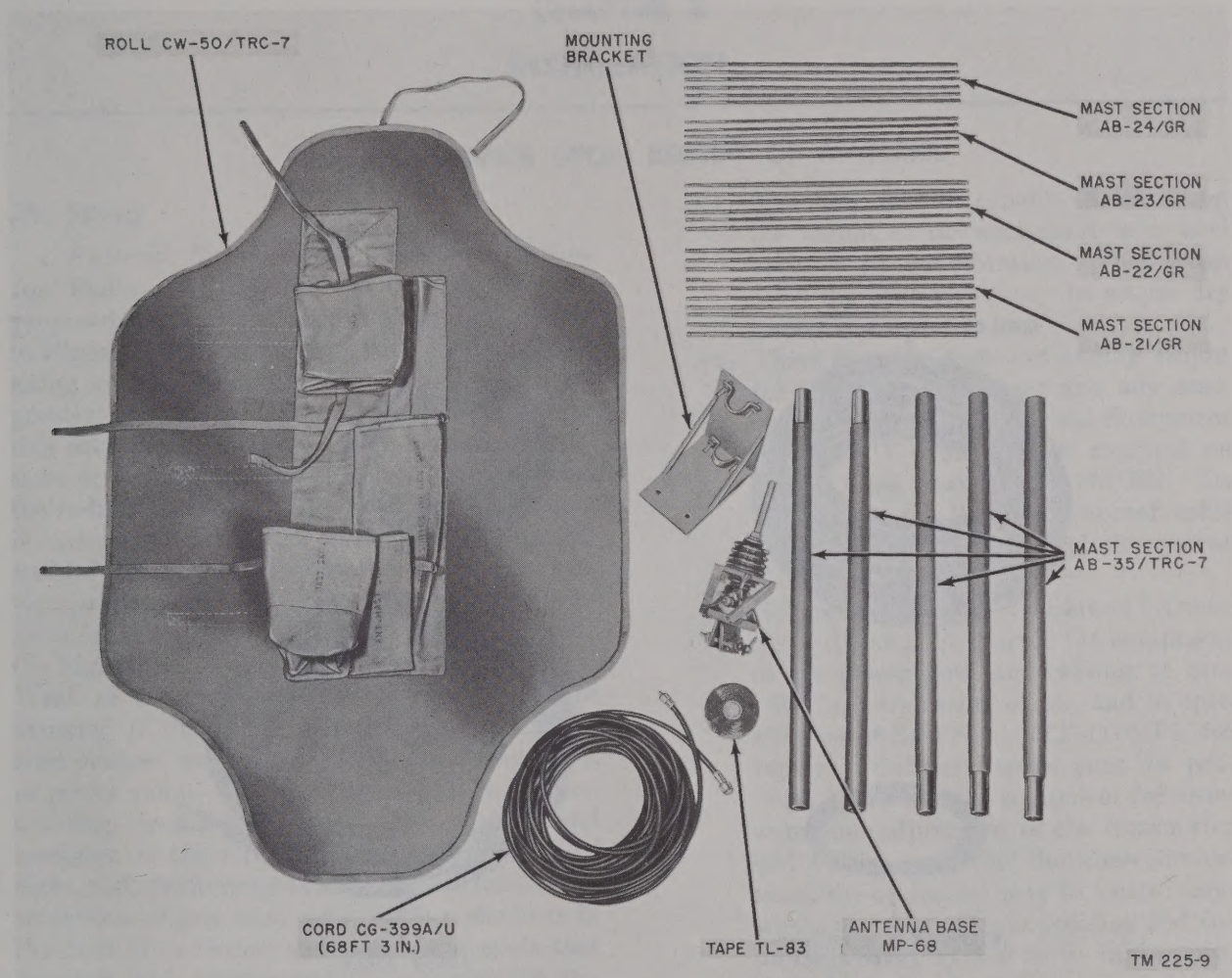


Figure 13. Antenna AS-612/U.

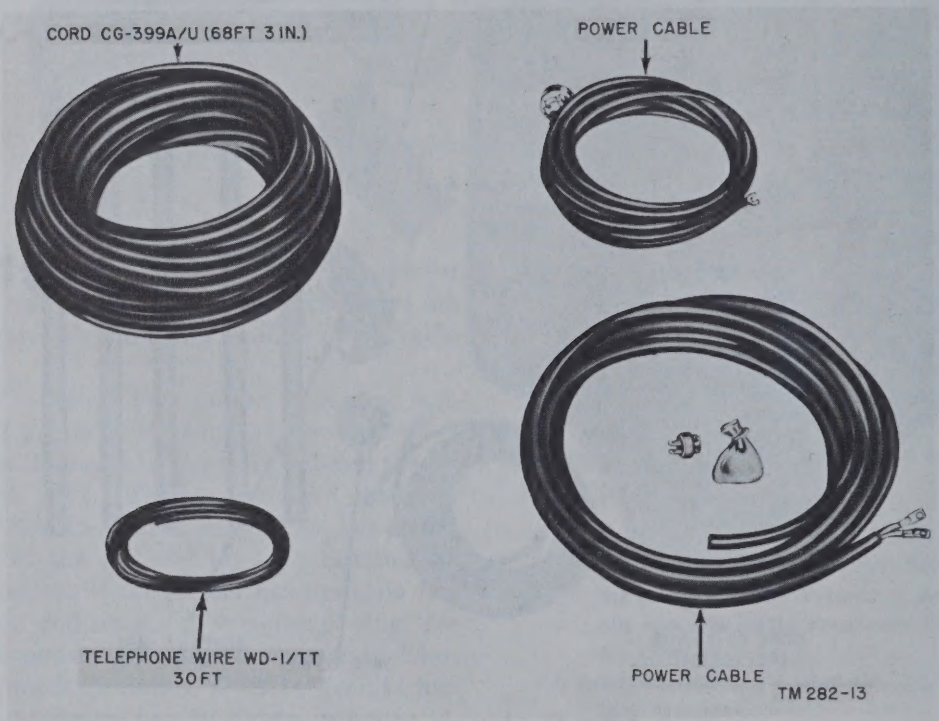


Figure 14. Radio Set AN/FRC–15 cables.

CHAPTER 2

INSTALLATION

Section I. SERVICE UPON RECEIPT OF MATERIEL

26. Siting

a. External Requirements. The best location for Radio Set AN/FRC–15 depends upon its proposed use and upon local conditions. Refer to Figure 15 for examples of both good and poor siting of the antenna. The terrain can vary greatly and there are many possible uses for this equipment; therefore, only general instructions or precautions will be given. Signals from the radio set have a greater range if the antenna is high and clear of hills, buildings, cliffs, densely wooded areas, and other obstructions. Depressions, valleys, and other low places are poor locations for radio reception and transmission because the high surrounding terrain absorbs rf energy. Weak or otherwise undesirable signals may be expected if the set is operated in proximity to steel bridges, underpasses, hospitals, power lines, or power units. Choose, if possible, a location on a hilltop or other elevation. Transmission and reception in the vhf ranges is primarily line of sight, with the horizon as the practical limit. Obstructions of any kind may produce shadows in the field of radiation and cause dead spots that interfere with communication to any mobile station which might have entered the shadow areas. Normally, transmission over water is better than over land. Be sure that drainage is adequate to prevent flooding the interior of any equipment cases. If the equipment is part of a communication center, but is not installed within the center, locate the equipment nearby. In locating the antenna, avoid obstructions which are above the horizontal plane of the ground in any direction. If the radio set is used only for point-to-point communication, it is permissible to locate the antenna so that the obstruction is on the side away from the direction of desired communication.

b. Interior Requirements. The shelter for the equipment must meet the following requirements:

(1) The floor must be capable of sustaining the weight of the equipment in a level position without vibration. When necessary, the equipment may be set on dry ground.

(2) There must be sufficient ceiling height for the radio equipment and any associated equipment. Electrical Equipment Cabinet CY–1221(*)/G is mounted on top of Base Stand MT–1176/FR. Do not remove the bottom rainproof cable entrance plate on Electrical Equipment Cabinet CY–1221(*)/G.

(3) Sufficient space must be allowed between the walls and the rear of the equipment to run power cords and cabling, to provide free circulation of air, and to open the door of Base Stand MT–1176/FR for repairs. Sufficient space must be provided in front of the equipment for operation and adjustment of the transmitter and receiver. Except for these limitations, the equipment may be located anywhere near the antenna location and the power source. If it is set up in the open, the case fronts should be protected during bad weather.

(4) Adequate lighting for day and night operation should be provided. Position the equipment so that the panel designations may be read easily by operating personnel. Artificial lighting should be arranged so that the light falls directly on the panel. A portable drop lamp with extension cord is useful for operating and maintenance personnel.

27. Line-of-Sight Transmission

a. General. Communication with these radio sets is accomplished in the vhf band of 25 to 50 mc. Radio waves at these frequencies tend to

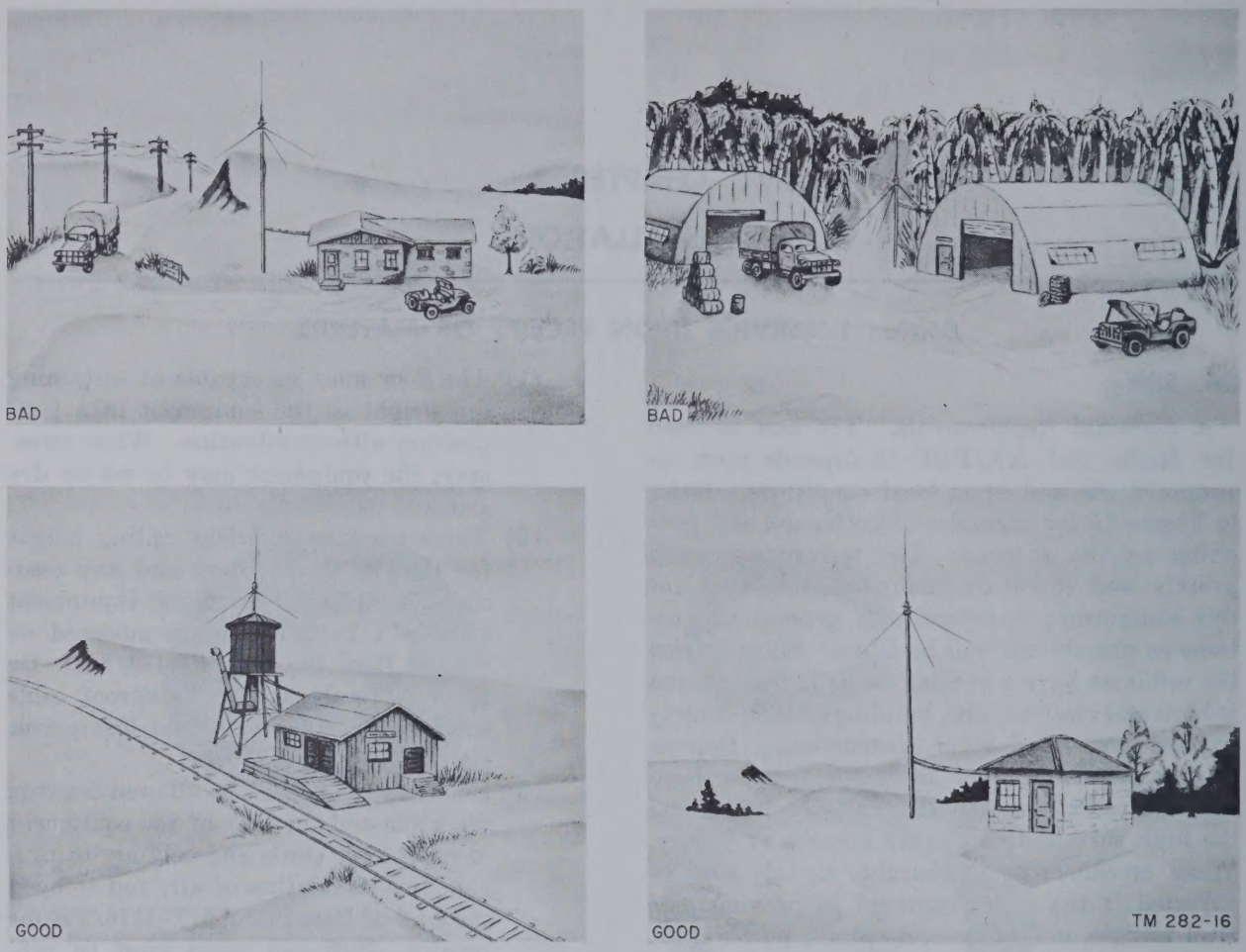


Figure 15. Siting Antenna AS–612/U.

travel in straight lines. For this reason, line-of-sight transmission paths are of major importance, because signal strength attenuates rapidly over paths which have obstructions between the transmitter and receiver. Although the radio waves bend slightly around obstructions, reliable communication occurs only when line-of-sight paths exist. Theoretically, line-of-sight transmission is attained when the transmitter antenna is within optical range of the receiver antenna. The most important factors limiting the line-of-sight distance are the curvature of the earth and intervening hills.

b. Curvature of Earth. The curvature of the earth limits the distance over which line of sight occurs. For example, with both the transmitting and the receiving antennas located 40 feet above sea level, the maximum distance that can be spanned before the line of sight is intercepted by the curvature of the earth is approximately 18 miles. This assumes the altitude of the intervening terrain also to be at sea level. To obtain a line-of-sight path 50 miles long, the height of each antenna must be at least 312.5 feet above sea level if the altitude of the intervening terrain is at sea level. To determine the maximum distance between two radio stations with the intervening terrain at sea level, use the following formula:

$D=\sqrt{2A}+\sqrt{2B}$ where:

D=distance in miles

A=height in feet of first radio station antenna.

B=height in feet of second radio station antenna.

c. Irregular Terrain.

(1) Propagation characteristics over irregular terrain are in marked contrast with those for smooth earth or sea water.

Here, the variation of field intensity with distance depends largely on the profile of the terrain between the transmitting and receiving antennas. An increase in distance may result in either decreased or increased field intensity, depending on the topography involved. Substantial changes in field intensity may result from relocation of stations, even without any changes in the distance between them.

(2) In anticipating propagation conditions over irregular terrain, the choice of antenna sites is very important. No basis of calculation can be given which will be satisfactory in every case. The received field intensity may be estimated for a given site involving a path of known profile. The selection of antenna sites should be based on estimated equipment performance for various available locations.

d. Intervening Hills. Intervening hills in a transmission path reduce signal strength when they obstruct the line of sight. Radio waves bend over these obstructions slightly, but bending is accomplished by a loss in signal strength; the greater the bending, the greater the loss. Certain combinations of communication sites with intervening hills may provide satisfactory signals due to reflections, but this condition is realized only by chance or by calculation with detailed terrain maps. It can be predicted reliably that satisfactory communication will be obtained if line of sight prevails. If line of sight does not exist, the path must be tested first to determine whether the site is suitable.

28. Uncrating, Unpacking, and Checking New Equipment

Caution: Rough handling during the unpacking process may break components in the set. Take every precaution to prevent damage. If possible, unpack the radio set in a location which is free from dust, dirt, and moisture.

a. Unpacking. Exploded views of the three crates which contain the components of Radio Set AN/FRC–15 are shown in figures 16, 17, and 18. They will aid in unpacking the equipment. These drawings show the various cartons and the method in which the packing materials are assembled. Use the following procedure for unpacking the equipment:

(1) Cut the metal bands at a point just below the box cover with a pair of tin snips or a large pair of diagonal cutting pliers.

(2) Remove the nails from the box cover. Use a nail puller. Avoid thrusting tools into the containers because damage to the equipment may result. Lift the box cover and carefully remove the packaged equipment. Save all the packaging material except the silica gel (dehydrating agent) for repacking for Zone of Interior or intertheater movement.

(3) Cut through and along the upper edges of the outer carton along three dimensions. The remaining uncut edges will act as a hinge. Open the flaps on the top of the outer carton.

(4) Open the moisture-vaporproof bag by slitting it along the edge of its seal and remove the inner carton containing the equipment. It may be easier to tip the wooden crate on its side when removing the large cabinets from their cartons because these cabinets are very heavy. With the crate on its side, the cabinet can be pulled out without lifting. Place cardboard under the cabinet while this is being done to prevent scratching the finish.

(5) When all packing material is removed from the components, the unpacking procedure is complete and the components can be checked against the packing list.

b. Checking. Always check the equipment for possible shipping damage such as dented cabinets, loose knobs, broken meter faces, bent shafts, broken tubes, or other signs of damage. To check each component properly, the covers must be removed so that inspection of the tops and bottoms of the chassis can be made. Refer to paragraph 29 for information concerning the removal of these covers.

29. Installation of Major Components

a. General. Before installing the components of Radio Set AN/FRC–15, the complete installation procedure should be read. Some of the preliminary adjustments can then be made while the units are being inspected. Installation procedures are given with the understanding that a suitable site has already been chosen and adequate power is available to operate the radio set. In general, the installation procedure consists of checking the

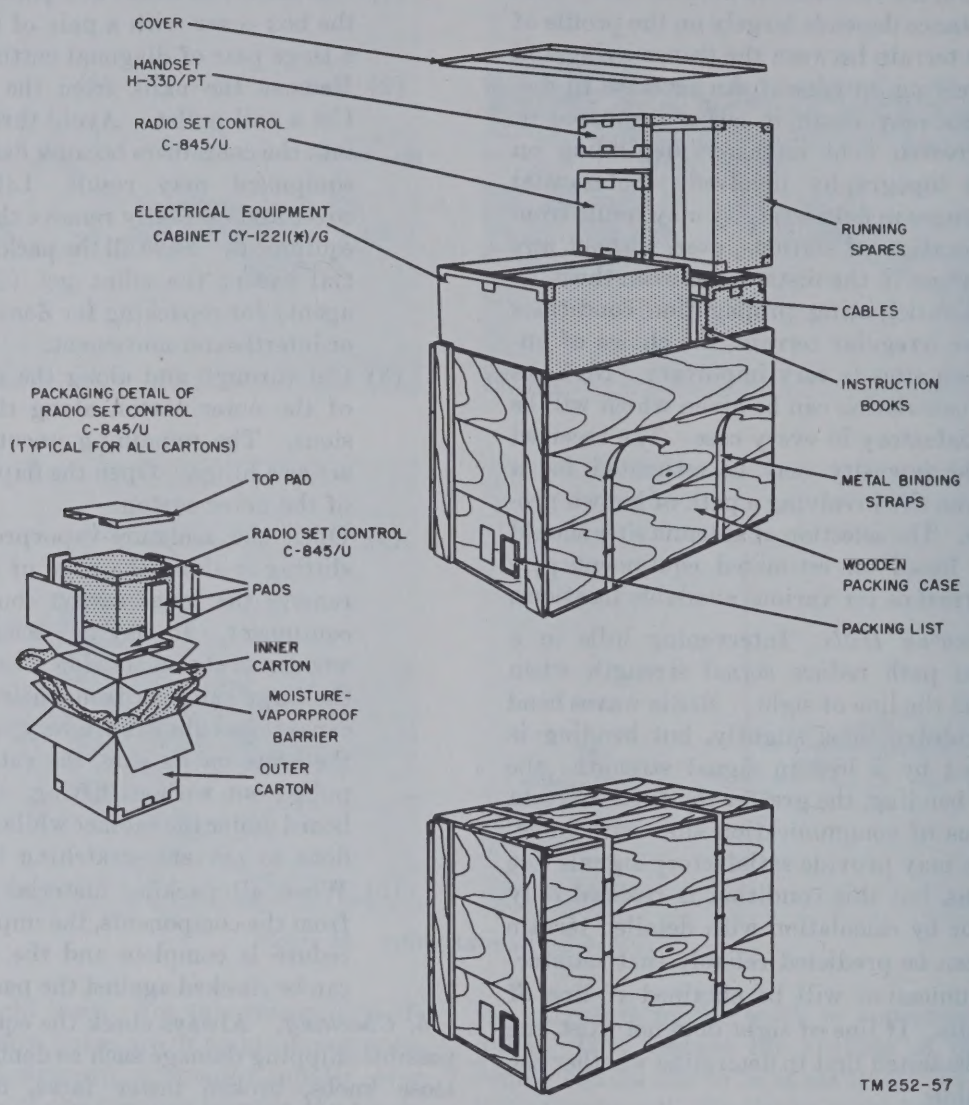


Figure 16. Packaging of Electrical Equipment Cabinet CY–1221(*)/G, accessories and other components

equipment and mechanical installation, and making electrical connections.

b. Checking Components. Inspect the exterior and interior of each component. The inspection should be the same as that used for preventive maintenance as explained in paragraphs 57 to 62. The plug-in components in Electrical Equipment Cabinet CY–1221 (*)/G must be removed before the cabinet can be inspected. These components are released from the cabinet by turning the locking handles as indicated on their front panels. During the checking of the receiver and transmitter, be sure that the correct operating crystals are installed. Refer to figures 19, 20, and 21 for the proper location of the components. The procedure for gaining access to the chassis of each component is as follows:

(1) *Radio Receiver R–257/U.* To remove the receiver from the equipment cabinet, turn the lock-in handle counterclockwise and slide the receiver forward out of the cabinet. Take off the top and bottom covers. The top cover is secured by a latch at the rear and the bottom cover is held by six airloc fasteners. Remove each plug-in unit and individually in-

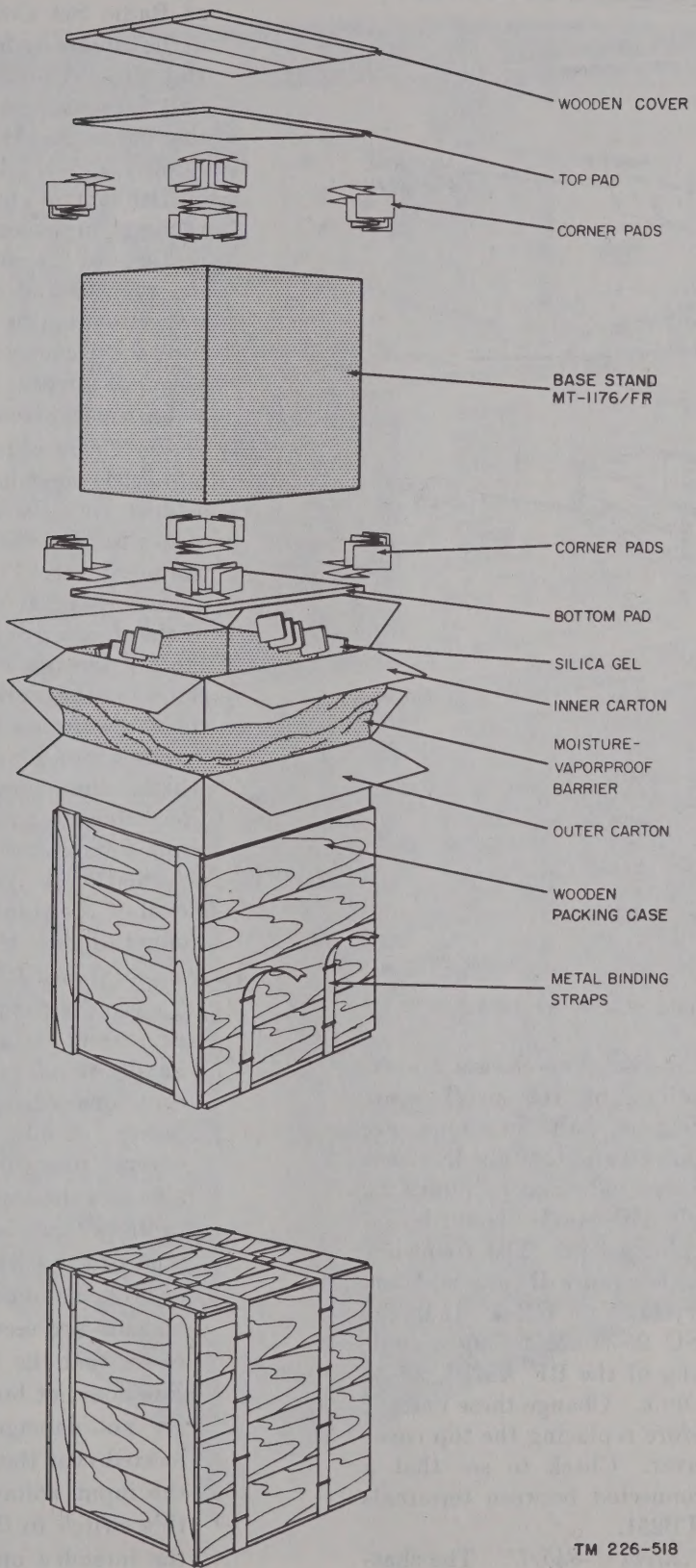


Figure 17. Packaging of Base Stand MT-1176/FR.

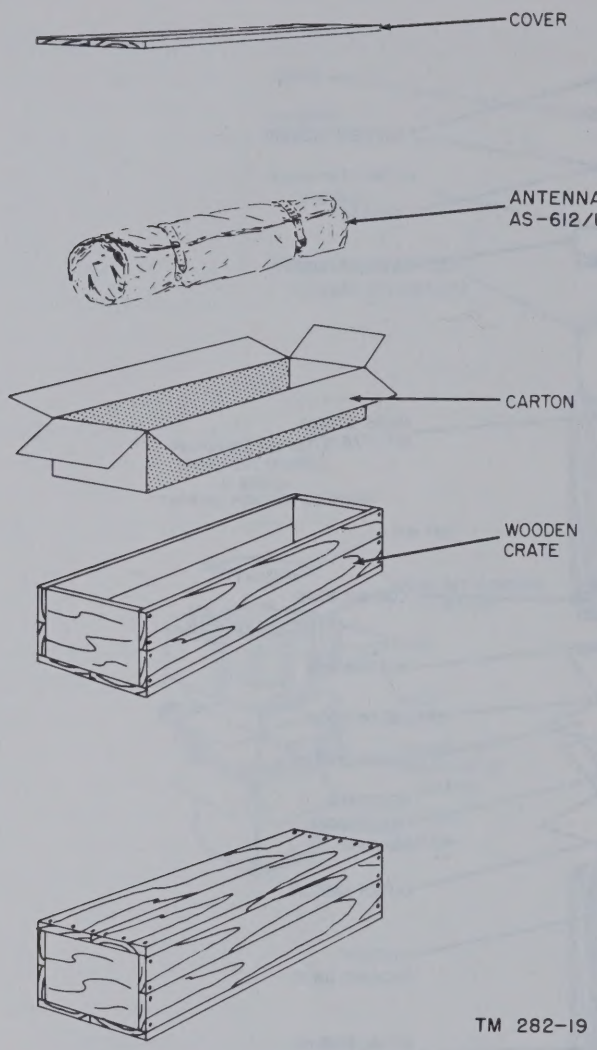


Figure 18. Packaging of Antenna AS-612/U.

spect each chassis. The chassis are exposed by pulling off the metal sleeve shields. Plug-in unit locations are shown in figure 30 and the tube locations of each unit are indicated in figure 22. Power Supply PP-846/U should be installed and plugged in. The frequency to which the receiver will tune is determined by Crystal Unit CR-32/U in the LOCAL OSC 25–50 MC plug-in unit and the tuning of the RF AMPL 25–50 MC plug-in unit. Change these units if necessary before replacing the top cover of the receiver. Check to see that a jumper is connected between terminals 7 and 8 of TB251.

(2) *Radio Set Control C-845/U.* The chassis which is attached to the front panel of Radio Set Control C-845/U is held in the cabinet by four latch type fasteners (fig. 10). Unlatch these fasteners and pull the chassis out of the cabinet. Make the routine checks and be sure that Power Supply PP-846/U is properly mounted on the control chassis and the interconnecting plug is securely connected. Connections to the control unit are made at the rear of the chassis; therefore, the inspection can be made immediately before these connections are wired to the terminal strips. Refer to figure 23 for plug-in parts location.

(3) *Radio Transmitter T-417/GR.* To remove the transmitter from the equipment cabinet, turn the lock-in handle counterclockwise, and slide the unit forward out of the cabinet. The transmitter has three covers. When these are taken off all sides of the chassis are exposed. While checking for damage, see that the cap connections on the driver and power output tubes are properly made. During the checking procedure it can be determined whether the correct crystals are installed. Check for the proper plate coil and antenna filter connections (par. 37). This information may save unnecessary removal of the transmitter at a later time. Refer to figure 24 for tube locations.

(4) *Power Supply PP-804/U.*

(*a*) To remove the power supply from the equipment cabinet, turn the lock-in handle counterclockwise, and slide the unit forward out of the cabinet. The power supply has two removable covers; one cover protects the right side and the top while the other cover protects the bottom. Be sure that none of the selenium rectifiers are bent or broken and that all the plug-in components are secured properly. Check to see that the fan blade on the right side does not bind and that the blades are not damaged. A toggle switch, located near the fan, is used to change the input voltage connections. Place this switch in the proper position for the intended operation before replacing covers (fig. 42).

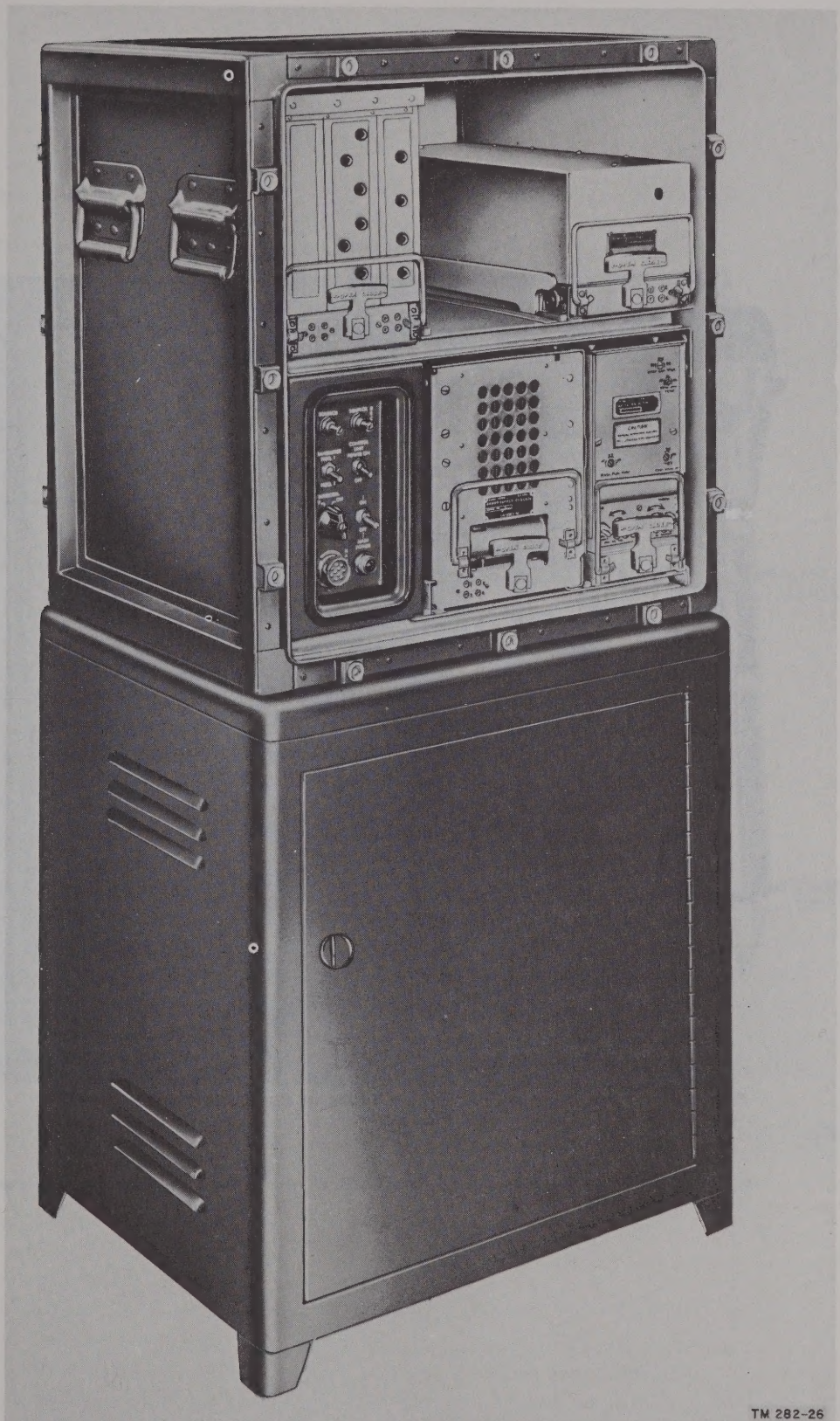


Figure 19. Electrical Equipment Cabinet CY–1221(*)/G, mounted on Base Stand MT–1176/FR.

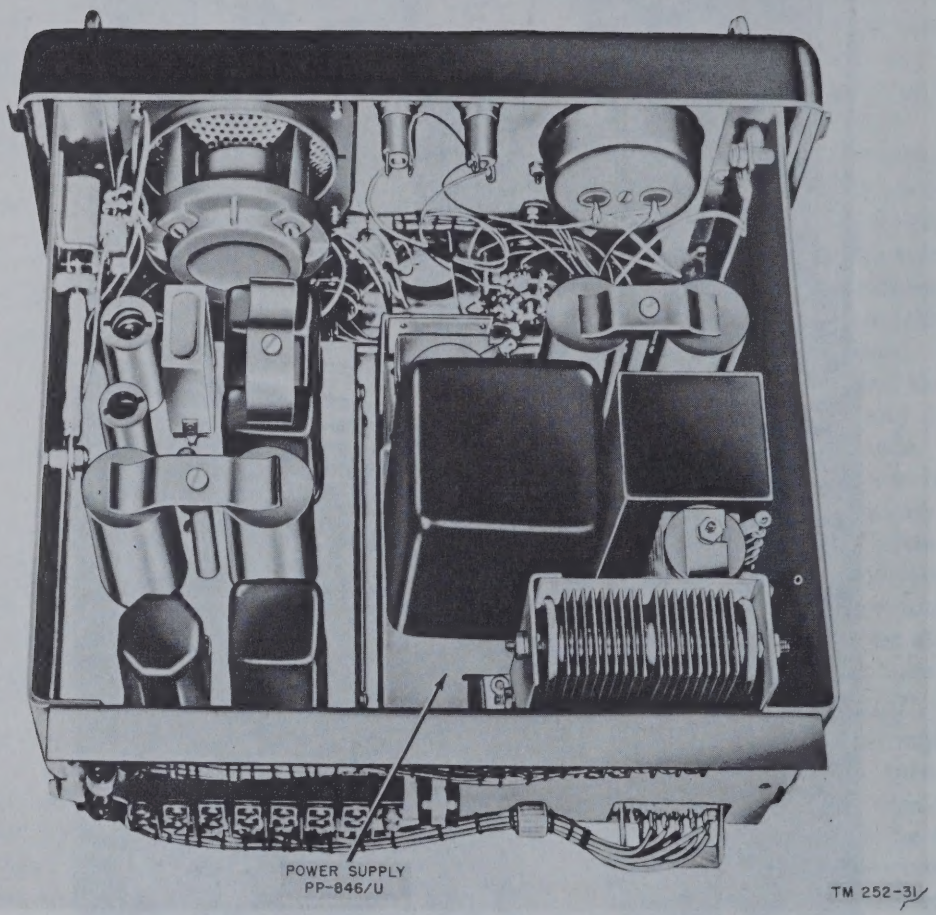


Figure 20. Power Supply PP-846/U installed in Radio Set Control C-845/U.

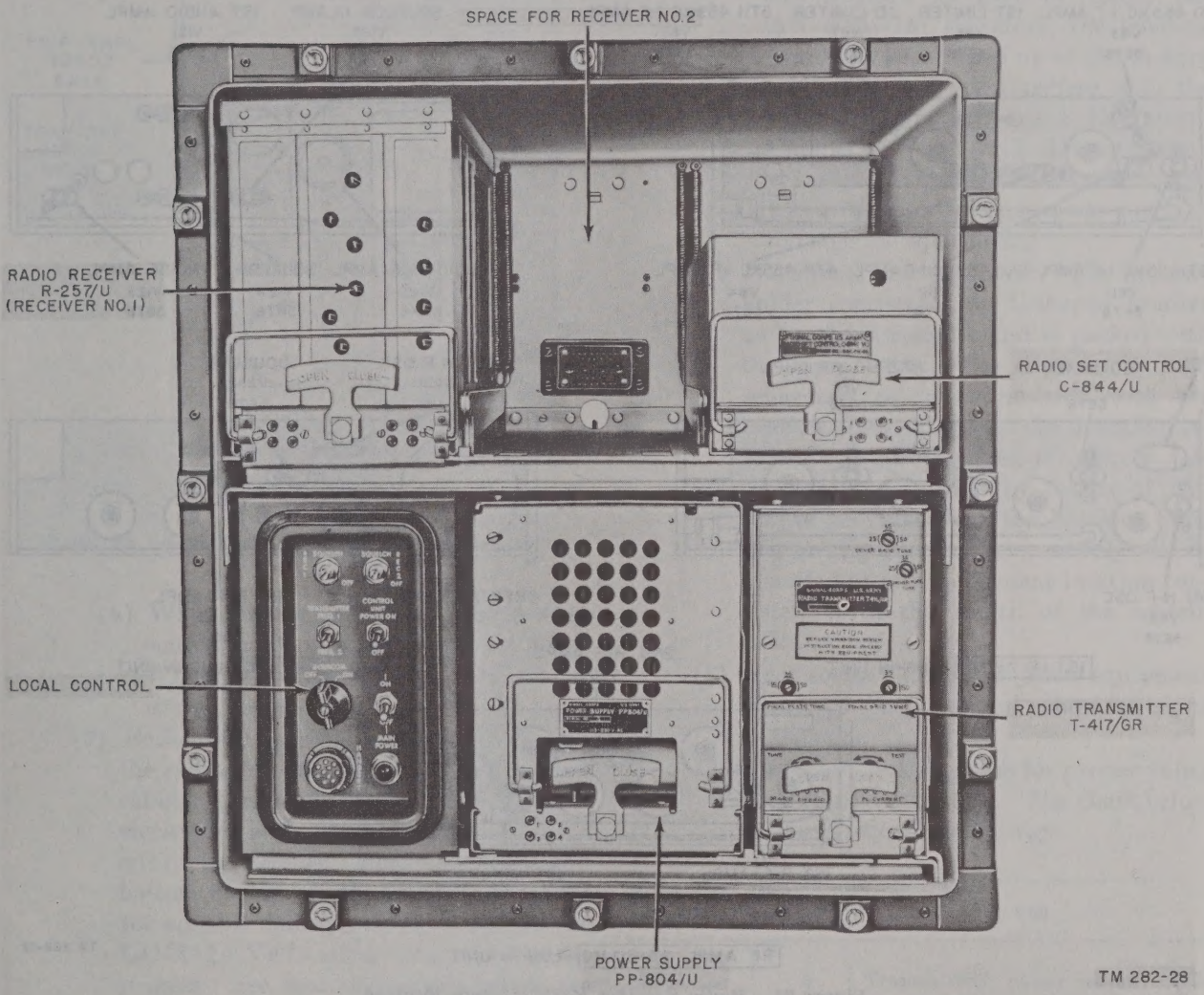


Figure 21. Location of components in Electrical Equipment Cabinet CY-1221(*)/G.

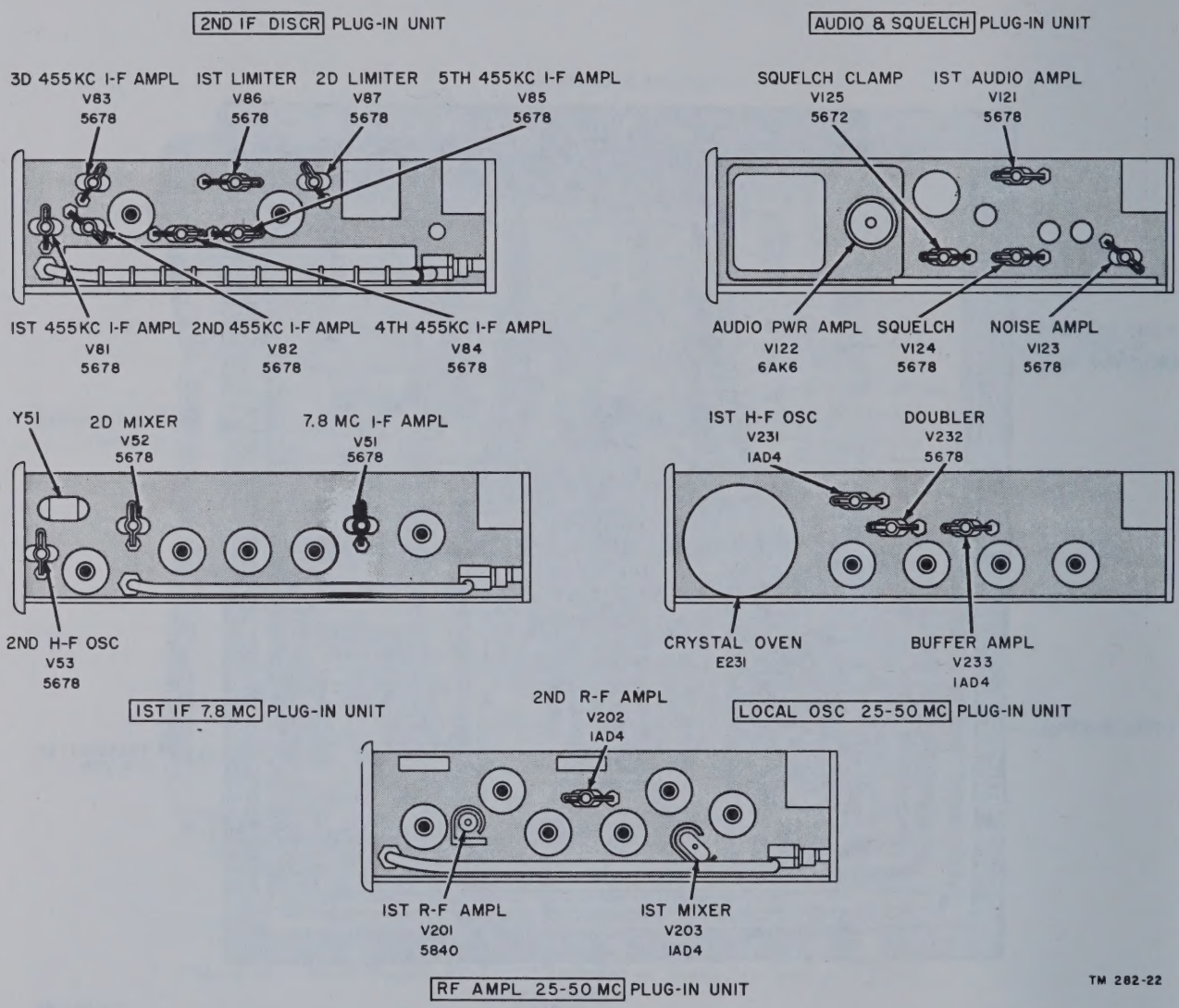


Figure 22. Radio Receiver R-257/U, tube location.

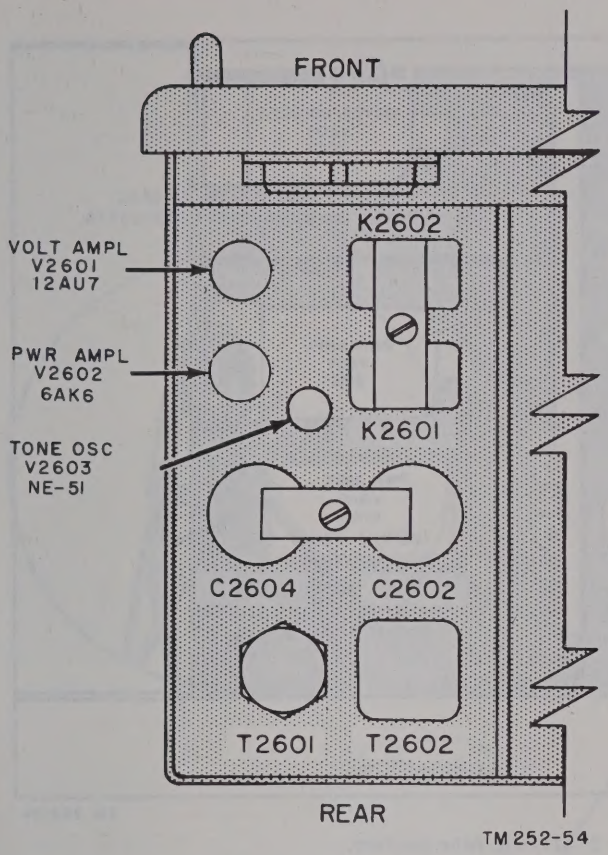


Figure 23. Radio Set Control C–845/U, tube location.

(*b*) When operating from a 115-volt ac source, use a 3-ampere fuse for F601. When operating from a 230-volt ac source, use a 1½-ampere fuse.

(5) *Radio Set Control C–844/U.* To remove the radio set control from the equipment cabinet, turn the lock-in handle counterclockwise, and slide the unit forward out of the cabinet. Remove the top and bottom covers of the control and check for possible damage. Do not disturb the LINE LEVEL adjustment during the process. See that all plug-in relays are seated properly. Replace the covers and reinstall the control unit in the cabinet.

(6) *Electrical Equipment Cabinet CY–1221-(*)/G.*

(*a*) When the components are out of Electrical Equipment Cabinet CY–1221-(*)/G, the rear connectors, guide rails, and springs should be checked. Remove the rear cover and examine the cabling and terminal strips. Leave the covers off so that connections and adjustments can be made.

(*b*) A copper stranded bonding braid located behind the front panel controls is attached to all Electrical Equipment Cabinets CY–1221A/G. This braid is not used with those Electrical Equipment Cabinet CY–1221A/G units which are shipped as part of Radio Set AN/FRC–15; therefore, the bonding braid has been taped up at the factory so that it will not interfere with the installation of Electrical Equipment Cabinet CY–1221A/G. Do not remove this tape as the braid may come in contact with high voltage points and may damage the equipment.

(7) *Installing handset holder.* The handset holder consists of an L-shaped bracket and a clip assembly, and is packed with the spare parts. The clip can be used separately or in conjunction with the bracket, depending on the installation. When using both parts, the clip is fastened to the bracket by means of two screws provided with the bracket. The clip or clip and bracket assembly can be mounted at any convenient location consistent with the length of the control cable.

(8) *Accessories.* Check all other equipment such as the handset and cables for signs of damage.

(9) *Fuses.* Check all fuses for proper value, contact, and condition. The chart below shows locations and ratings.

Fuse	Rating (amperes)	Unit
F601	3	Transmitter power supply (125 volts ac).
F601	1.5	Transmitter power supply (230 volts ac).
F3001	2	Receiver power supply.

30. Antenna Installation Procedure

(fig. 25)

a. Check the antenna and parts for proper assembly. Check for a broken insulator, bent rods or radiator, or a damaged coaxial connector.

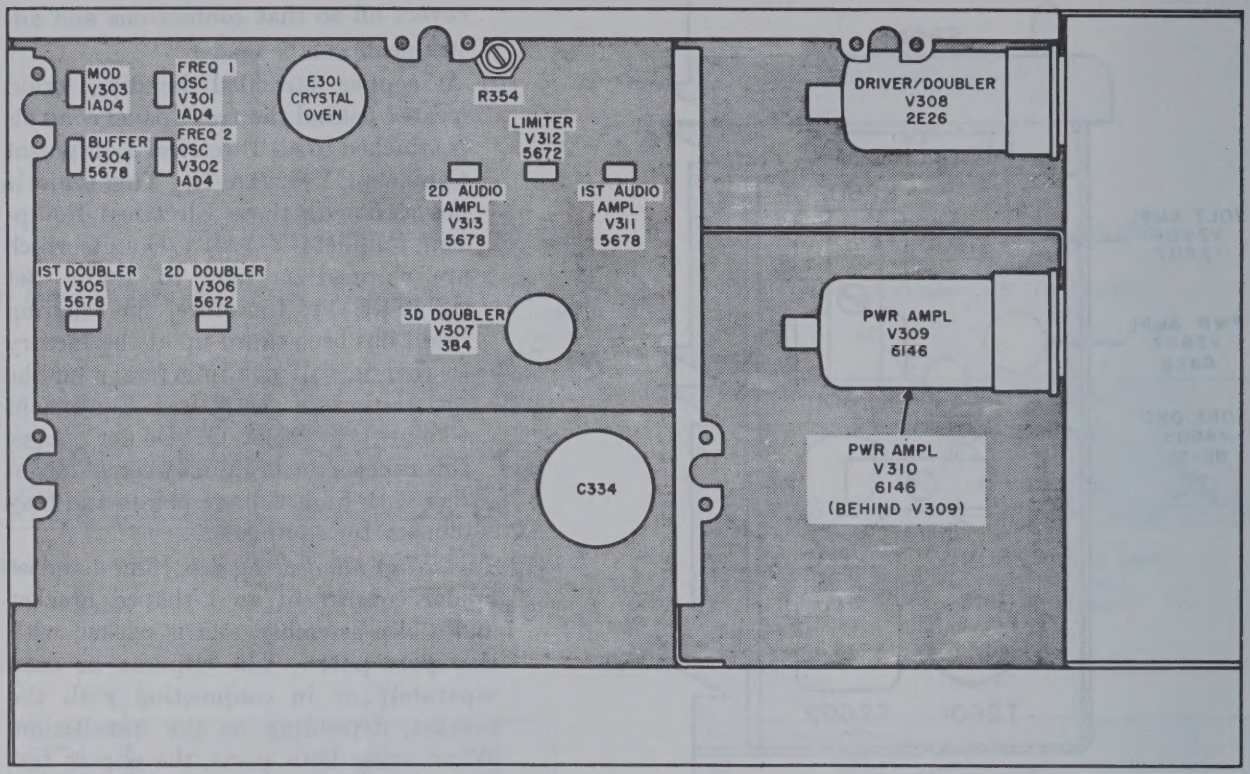


Figure 24. Radio Transmitter T–417/GR, tube location.

b. Fasten the mounting bracket securely to the mounting surface; for masonry, use four Akerman lead anchors. (Lead anchors not supplied.)

c. Loosen the U-shaped clamps on the mounting bracket.

d. Fasten Mast Section AB–35/GR to the mounting bracket with the U-shaped clamps.

e. Add another Mast Section AB–35/TRC–7 to the one already mounted.

f. Before placing the third mast section in place, attach Antenna Base MP–68 to it by means of the two pipe vise-type clamps.

g. Unscrew the protective cap from the insulator and attach the coaxial connector to the antenna base.

h. Tighten the screw that holds the ground strap to the antenna base.

i. Tape the coaxial cable to Mast Section AB–35/GR at approximately 1-foot intervals.

j. Attach the whip and ground plane sections. The antenna assembly chart in *l* below lists the proper sections to use for the desired operating frequency.

k. Mount this assembly to the mast sections attached to the mounting bracket.

l. Attach a piece of wire from the mounting bracket to a good ground as a protective measure.

ANTENNA ASSEMBLY CHART

Vertical whip	Freq (mc)	Ground plane sections (3)
2 MS–21/GR	25–29	2 MS–21/GR
1 MS–22/GR		1 MS–22/GR
1 MS–23/GR		1 MS–23/GR
1 MS–24/GR		1 MS–24/GR
1 MS–21/GR	29–36	2 MS–21/GR
1 MS–22/GR		1 MS–22/GR
1 MS–23/GR		1 MS–23/GR
1 MS–24/GR		1 MS–24/GR
1 MS–22/GR	36–42	1 MS–21/GR
1 MS–23/GR		1 MS–22/GR
1 MS–24/GR		1 MS–23/GR
		1 MS–24/GR
1 MS–22/GR	42–50	1 MS–22/GR
1 MS–23/GR		1 MS–23/GR
1 MS–24/GR		1 MS–24/GR

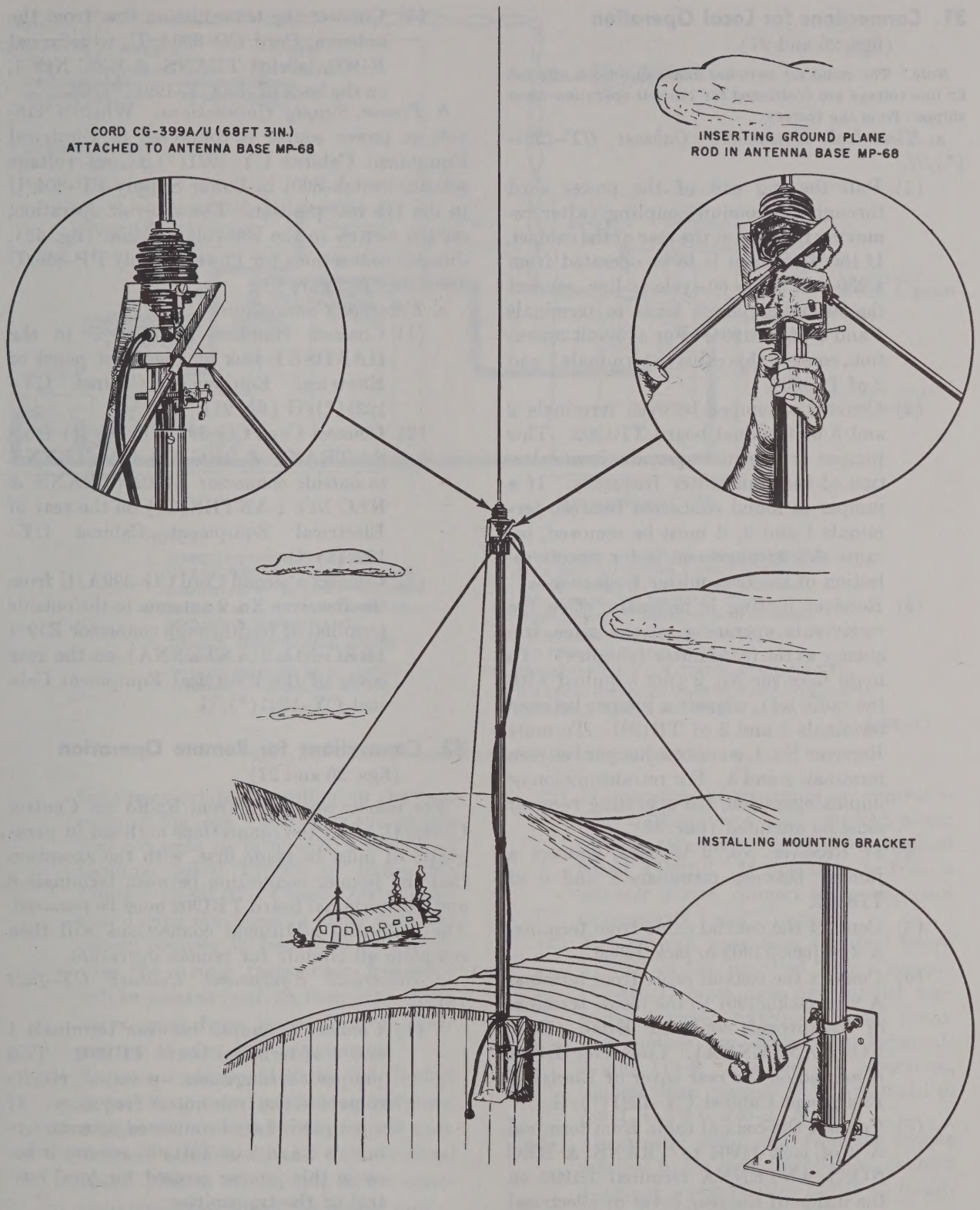


Figure 25. Antenna AS–612/U, assembly and installation.

31. Connections for Local Operation

(figs. 26 and 27)

Note. The radio set switches and connections affected by line voltage are positioned for 115-volt operation when shipped from the factory.

a. Electrical Equipment Cabinet CY–1221(*)/G.

(1) Pull the lug end of the power cord through the conduit coupling (after removing the cap) at the rear of the cabinet. If the equipment is to be operated from a 230-volt 50- to 60-cycle ac line, connect the incoming power leads to terminals 1 and 3 of TB1904. For 115-volt operation, connect this cable to terminals 1 and 2 of TB1904.

(2) Connect a jumper between terminals 2 and 3 of terminal board TB1902. This jumper arrangement permits local selection of the transmitter frequency. If a jumper is found connected between terminals 1 and 2, it must be removed, because this arrangement is for remote selection of the transmitter frequency.

(3) Receiver muting is necessary when the receiver is operating on the same frequency as the transmitter (simplex). To mute Receiver No. 2 (not supplied with the radio set), connect a jumper between terminals 1 and 2 of TB1901. To mute Receiver No. 1, connect a jumper between terminals 2 and 3. For retransmission or duplex operation, the operating receiver must be unmuted (par. 33).

(4) If Receiver No. 2 is used, connect a jumper between terminals 8 and 9 of TB1902.

(5) Connect the coaxial cable from terminal A 2 of jack J1902 to jack J1906.

(6) Connect the coaxial cable from terminal A 2 of jack J1901 to the inside terminal of feedthrough connector E1901 (REC NO. 2 ANTENNA). Connector E1901 is located on the rear cover of Electrical Equipment Cabinet CY–1221(*)/G.

(7) Connect the coaxial cable from terminal A 2 of jack J1904 to TRANS. & REC NO. 1 ANTENNA terminal E1902 on the inside of the rear cover of Electrical Equipment Cabinet CY–1221(*)/G. Use adapter E1903 to make the connection.

(8) Connect the transmission line from the antenna, Cord CG–399A/U, to terminal E1902, labeled TRANS. & REC NO. 1, on the back of the CY–1221(*)/G.

b. Power Supply Connections. When a 115-volt ac power source is connected to Electrical Equipment Cabinet CY–1221(*)/G, set voltage selector switch S601 in Power Supply PP–804/U in the 115-volt position. For 230-volt operation, set the switch in the 230-volt position (fig. 42). Jumper connections for Power Supply PP–846/U are shown in figure 43.

c. External Connections.

(1) Connect Handset H–33D/PT to the HANDSET jack on the front panel of Electrical Equipment Cabinet CY–1221(*)/G (fig. 21).

(2) Connect Cord CG–399A/U (68 ft) from the TRANS. & REC NO. 1 ANTENNA to outside connector E1902 (TRANS. & REC NO. 1 ANTENNA) on the rear of Electrical Equipment Cabinet CY–1221(*)/G.

(3) Connect a second Cord CG–399A/U from the Receiver No. 2 antenna to the outside terminal of feedthrough connector E1901 (REC NO. 2 ANTENNA) on the rear cover of the Electrical Equipment Cabinet CY–1221(*)/G.

32. Connections for Remote Operation

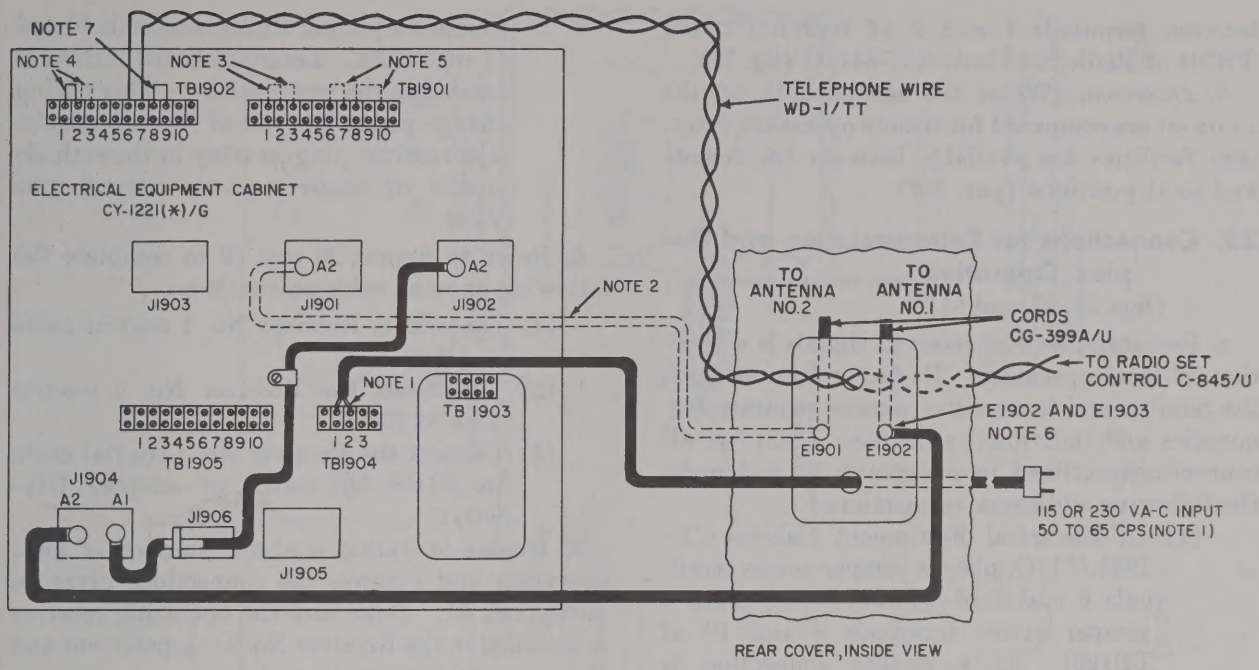
(figs. 26 and 27)

For remote operation from Radio Set Control C–845/U, all of the connections outlined in paragraph 31 must be made first, with the exception that the jumper connection between terminals 8 and 9 on terminal board TB1902 must be removed. The following additional connections will then complete all circuits for remote operation.

a. Electrical Equipment Cabinet CY–1221(*)/G.

(1) Connect a jumper between terminals 1 and 2 of terminal board TB1902. This jumper arrangement permits remote control of the transmitter frequency. If a jumper is found connected between terminals 2 and 3 of TB1902, remove it because this jumper is used for local control of the transmitter.

(2) Connect a 600-ohm line (Wire WD–1/TT) from terminals 6 and 7 of terminal board TB1902, and pass it through



NOTES:

1. CONNECT A-C POWER AS FOLLOWS:
   115 V A-C, TERMINALS 1 AND 2 ON TB1904.
   230 V A-C, TERMINALS 1 AND 3 ON TB1904.
2. RECEIVER NO. 2 ANTENNA CONNECTION, IF USED, SHOWN IN BROKEN LINES.
3. TO MUTE RECEIVER NO. 1, JUMPER TERMINALS 2 AND 3 ON TB1901.
   TO MUTE RECEIVER NO. 2, JUMPER TERMINALS 1 AND 2 ON TB1901.
4. WHEN REMOTE TRANSMITTER FREQUENCY CONTROL FROM RADIO SET CONTROL C-845/U IS DESIRED, JUMPER TERMINALS 1 AND 2 ON TB1902. WHEN LOCAL TRANSMITTER FREQUENCY CONTROL IS DESIRED, JUMPER TERMINALS 2 AND 3 ON TB1902.
5. FOR RETRANSMISSION: JUMPER TERMINALS 6 AND 7 AND TERMINALS 8 AND 10 ON TB1901.
6. CONNECTOR E1903 IS A COAXIAL CABLE ADAPTER.
7. FOR LOCAL OPERATION USING RECEIVER NO. 2, JUMPER TERMINALS 8 AND 9 ON TB1902.

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Figure 26. Internal connections of Radio Set AN/FRC-15.

the upper conduit coupling on the rear cover of the case. The other end of this line connects to terminals 2 and 3 of terminal board TB2603 in Radio Set Control C–845/U. Check this connection during operation to make sure that correct polarity has been observed; otherwise the wrong transmitter frequency will be selected (par. 69, item 19). Keep wires away from power lines or other sources of electrical interference.

(3) To use an additional Radio Set Control C–845/U unit for monitoring purposes, connect it in parallel with the first unit. Connect terminals 2 and 3 on terminal board TB2603 of one unit to the corresponding terminals of the second unit.

b. Radio Set Control C–845/U.

(1) Connect Handset H–33D/PT to the front panel jack marked HANDSET.

(2) If operation of the radio set control is from a 115-volt ac source, connect a power cord to terminals 1 and 2 of terminal board TB2602. If operation is from a 230-volt source, connect the power cord to terminals 1 and 3 instead.

(3) For 115-volt operation, terminal board TB3001 in the installed Power Supply PP–846/U must have one jumper connected between terminals 1 and 115–1, and another jumper between terminals 2 and 115–2. For 230-volt operation, connect these jumpers from terminal 1 to 230–1, and 2 to 230–2 (fig. 43).

(4) For greater audio gain from the remote position to the local installation, connect a jumper across resistor R2615 on terminal board TB2605 (fig. 71).

c. Radio Set Control C–844/U. For greater audio gain from this local control to the remote Radio Set Control C–845/U, connect a jumper

between terminals 1 and 2 of terminal board TB701 of Radio Set Control C–844/U (fig. 78).

d. Intercom. When the components of the radio set are connected for remote operation, intercom facilities are available between the remote and local positions (par. 50*f*).

33. Connections for Retransmission and Duplex Operation

(figs. 26, 27, and 61)

a. Retransmission of received signals is a function of local operation. During retransmission, the receiver and transmitter require separate frequencies and individual antennas. Complete all connections outlined in paragraph 31 and make the following additional connections:

(1) In Electrical Equipment Cabinet CY–1221 (*)/G, place a jumper across terminals 6 and 7 of TB1901; also, place a jumper across terminals 8 and 10 of TB1901. If a jumper connection is found between terminals 2 and 3 of TB1901, remove it; otherwise the receiver will be muted when the transmitter is turned on. Connect a jumper across terminals 2 and 3 of TB1902 to permit local selection of transmitter frequency.

(2) In Radio Set Control C–844/U, connect a jumper between terminals 2 and 3 of TB701 to allow the audio output of Receiver No. 1 to modulate the transmitter. If a jumper connection is found between terminals 1 and 2 of TB701, remove it.

(3) In Radio Receiver R–257/U, remove the jumper across terminals 9 and 10 on TB251. Insert Receiver Subassembly MX–1547/G in the receiver (fig. 30). Connect a jumper across terminals 10 and 11 of TB251. Terminal board TB251 is located in the receiver base. This wiring change places the coil of the retransmission receiver plug-in relay in the cathode circuit of receiver power output tube V122.

b. Refer to figures 26 and 82 to complete the following antenna cable connections:

(1) Disconnect Receiver No. 1 coaxial cable at J1906.

(2) Disconnect the Receiver No. 2 coaxial cable at E1901.

(3) Connect the Receiver No. 1 coaxial cable to E1901 by means of adapter UG–201/U.

c. Duplex operation is also a function of local operation and requires the connections given in paragraph 31. Make sure the operating receiver is installed in the Receiver No. 2 compartment and that a second antenna is used.

34. Service Upon Receipt of Used or Reconditioned Equipment

If used equipment is received for service, check for tags or other sources of information regarding the condition of the equipment. If any wiring changes have been made, note the changes in this manual, preferably on the schematic diagram. Include the serial and order numbers of the modified units. When the condition of the equipment is doubtful and no information is available, perform the final test procedures described in paragraphs 113 to 117. A properly reconditioned piece of equipment may be considered to be in the same condition as new equipment, and instructions for installation and operation given in chapter 2 may be followed.

Section II. PRESETTING AND INITIAL ADJUSTMENT OF EQUIPMENT

35. General

a. Normally, Radio Set AN/FRC–15 operates at frequencies which are initially set up at the time of installation. It is possible to change both the receiver and transmitter frequencies within the range of 25 to 50 mc. Two frequencies are provided in the transmitter; however, they must always be within .25 mc of each other. Therefore, if one frequency is changed and the maximum separation is exceeded, the other frequency must also be changed, because the transmitter will not operate efficiently with too wide a separation of output frequencies. Because provision is made to use two receivers, it is possible to choose two preset receiver frequencies if the second receiver is installed. The presetting of the transmitter and receiver frequencies is not a part of the normal operating procedure. There are three methods to effect frequency changing, and each requires a different amount of skill. These methods are:

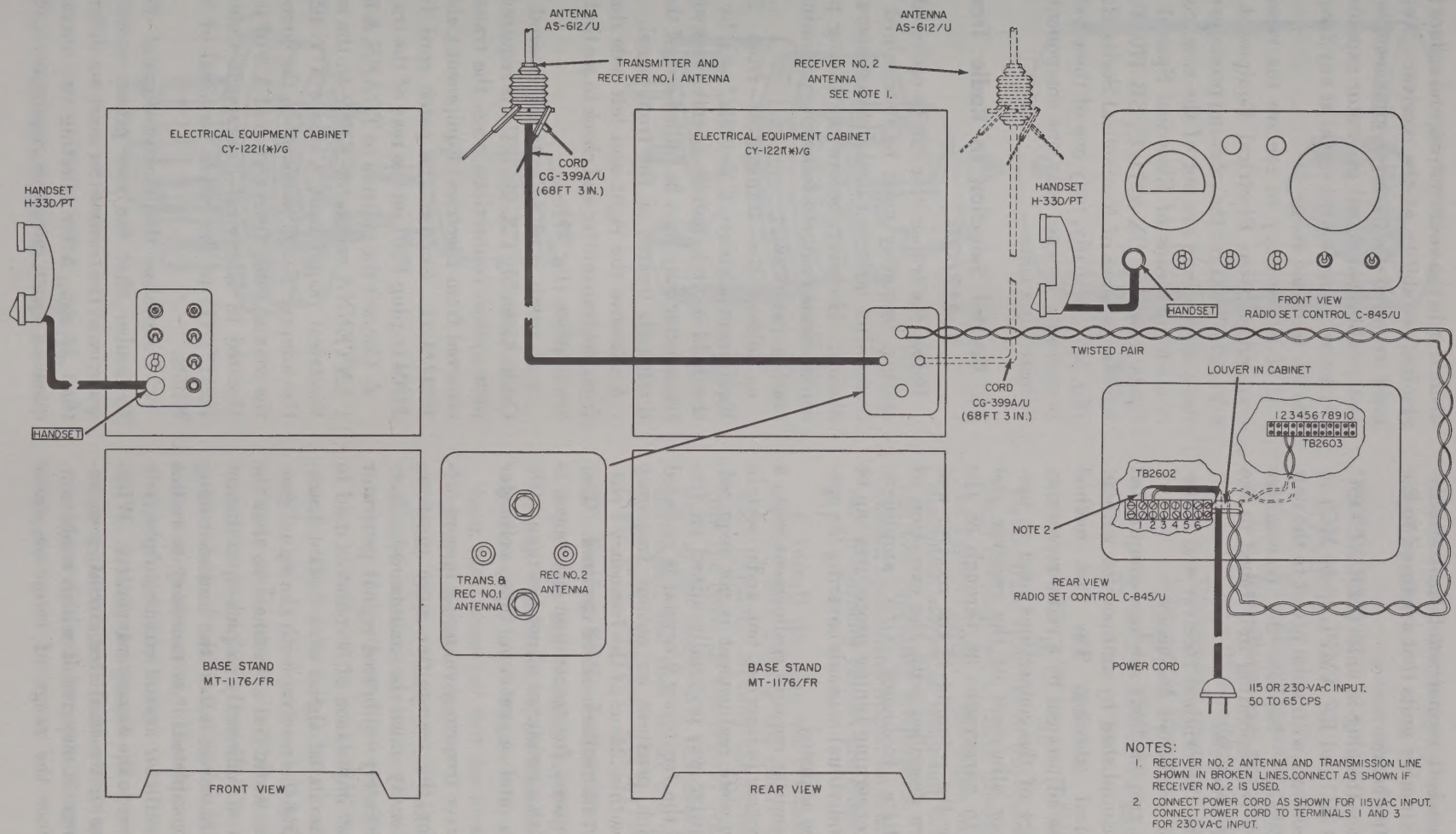

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Figure 27. External connections of Radio Set AN/FRC–15.

(1) Replace both receivers and the transmitter with other units that are tuned to the new frequency.

(2) Replace the plug-in units (LOCAL OSC 25–50 MC and RF AMPL 25–50 MC) in the receivers with units preset to the new frequencies. Replace the transmitter with a corresponding unit tuned to the new frequencies.

(3) Retune the original receiver and transmitter to the new frequency.

b. The first two methods are not complicated and can be accomplished by an operator without special technical training. The last method requires precise adjustment by a radio repairman with knowledge of the connections used in performing proper alinement of the receiver and transmitter. In paragraphs 36 through 38 the procedures for the retuning of the receiver and transmitter are described with the exception of the intermediate frequency (if.) amplifiers. More details concerning tuning procedures can be found in the individual manuals covering the specific units to be adjusted.

c. The transmitter requires realinement when a new set of crystals is inserted, but under certain conditions complete realinement is not required. If the transmitter was originally alined on frequency 1, and the frequency 2 crystal is replaced with one which produces an output frequency which is still within .25 mc of the frequency 1 output frequency, no realinement is required. Test equipment required for transmitter alinement is a voltmeter with a resistance of not less than 1,000 ohms-per-volt, and a vacuum tube voltmeter (vtvm).

d. The receiver frequency changing is more difficult than for the transmitter since optimum receiver sensitivity must be maintained. Normally, an accurately calibrated signal generator with an output impedance of 50 ohms is used to provide the simulated signal of a distant transmitter. Tuning the receiver with the signal generator provides an initial adjustment so that the receiver is tuned sufficiently to pick up a distant transmitter; however, after the initial tuning procedure is completed, it is necessary to retune the receiver oscillator crystal circuit to precisely tune the receiver to the distant transmitter. Without the tuning of the oscillator circuit, poor receiver performance may result which could considerably reduce the range of reception, cause distortion in the audio output, and reduce the noise elimination ability of the receiver. Test equipment required for receiver alinement is a vtvm and a calibrated signal generator capable of supplying an unmodulated signal at any frequency in the 25- to 50-mc range.

e. It is necessary to remove the receiver and transmitter from Electrical Equipment Cabinet CY–1221(*)/G for the retuning procedure. When these components are out of the case, connection is made by means of Electrical Special Purpose Cable Assembly CX–2371/U, SB–170, Test Cable for Maintenance of Nontactical Series Radio Sets (fig. 39). Usually, only one of these patch cords is necessary because only one component need be adjusted at a time.

36. Crystal Selection in Radio Transmitter T–417/GR

Before the transmitter can be operated, the operating frequency must be determined and the transmitter must be tuned for that operating frequency. However, before the tuning procedure can be carried out, the following preliminary steps must be performed:

a. Release the transmitter from Electrical Equipment Cabinet CY–1221(*)/G by turning the hold-in lock handle counterclockwise. The transmitter may then be pulled out of the case by the handle located on the front panel.

b. Remove the right and left side dust covers from the transmitter and check to see that all tubes are in place (fig. 24).

c. A patch cord (Electrical Special Purpose Cable Assembly CX–2371/U) is required to complete system connections when the transmitter is removed from Electrical Equipment Cabinet CY–1221(*)/G. Connect the patch cord from jack J1904 to plug P301 on the rear of the transmitter.

d. Connect the antenna to TRANS. & REC NO. 1 ANTENNA connector E1902 on the outside of Electrical Equipment Cabinet CY–1221(*)/G. Use adapter E1903 to complete the connection of the coaxial cable from terminal A 2 of jack J1904 (located in Electrical Equipment Cabinet CY–1221(*)/G) to the inside terminal of connector E1902.

e. Determine the correct crystal frequency. Remember that the two preset operating frequencies of the transmitter must not differ by more than .25 mc. After selecting two operating frequencies which meet this requirement, choose the

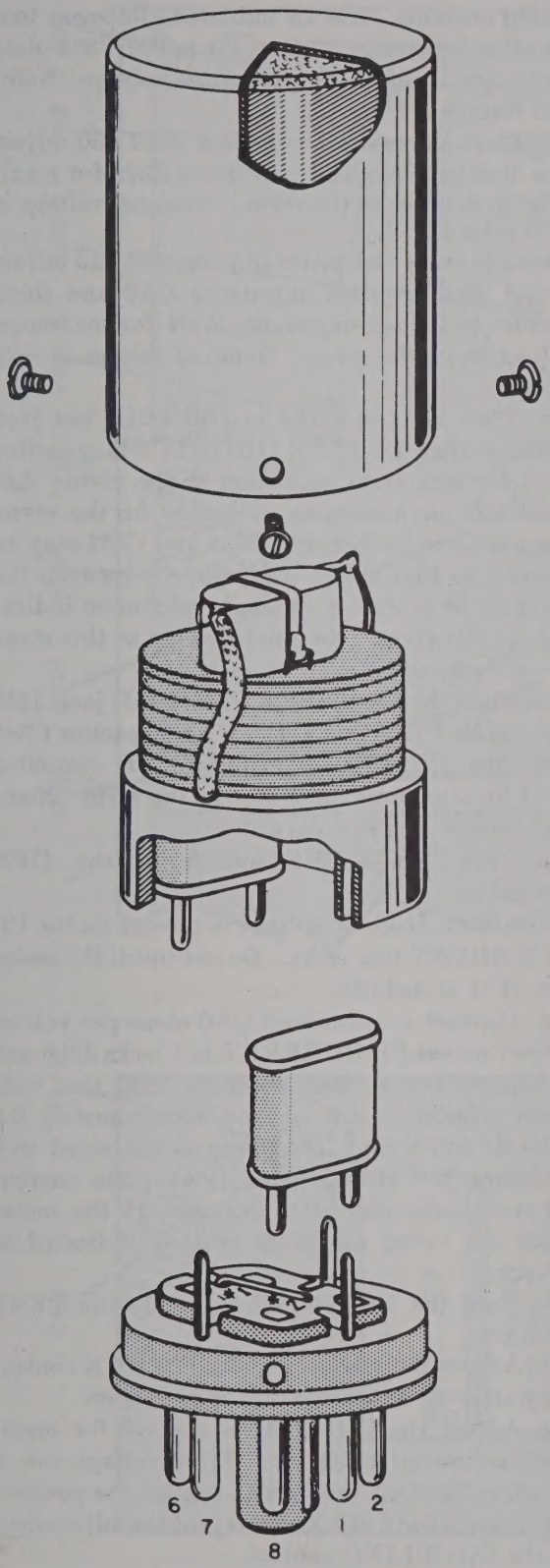

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Figure 28. Transmitted crystal oven, exploded view.

correct crystal frequency by means of the following formula:

$$\text{crystal frequency} = \frac{\text{operating frequency (kc)}}{16}$$

Example:

F1=desired operating frequency=40 mc.
F2=alternative operating frequency=40±.25 mc=39.75 or 40.25 mc.
X1=crystal frequency required for F1.
X2=crystal frequency required for F2.

$$X1 = \frac{F1}{16} = \frac{40{,}000 \text{ kc}}{16} = 2500 \text{ kc.}$$

$$X2 = \frac{F2}{16} = \frac{40{,}250 \text{ kc}}{16} = 2515.625 \text{ kc.}$$

To maintain accuracy of the operating frequency, carry division out to three places to the right of the decimal point. The above example used the maximum allowable frequency difference between the two operating frequencies. Actually, more efficient transmitter operation is attained when the two frequencies chosen are closer together (par. 35).

f. Install the required crystals (fig. 28). To do this, first unplug the entire crystal oven assembly, E301. Remove the three screws that secure the cover of the crystal oven to the socket, unplug the heater and thermostat element from the socket, and then insert the crystals into the socket base. Reassemble in the reverse order.

37. Tuning Radio Transmitter T–417/GR

To tune the transmitter, two meters are required. One is a vtvm for measuring grid voltage, and the other is a voltmeter with a sensitivity of at least 1,000 ohms per volt for measuring the voltage drop across a resistor.

Note. Correct tuning of the transmitter will not be possible unless the antenna radiator and ground plane rods are of the correct length (par. 30).

a. Install the proper coil in the final tank circuit. The 9-turn coil (L319) is used for the 25- to 32-mc band; the 6-turn coil (L317) is used for the 32- to 40-mc band; the 5-turn coil (L316) is used for the 40- to 50-mc band. The coil for the particular band used is fastened to the terminal board by two 6–32 screws. The other coils are kept on the left side dust cover.

b. Install the proper jumper connections for the antenna filter. Solder the jumpers to the terminal strip connectors according to the following chart:

Antenna filter connections

Freq (mc)	Strap		
25 to 32	2–3	4–6	9–8
	2–1	4–5	9–10
32 to 40	2–3	4–6	9–8
40 to 50	2–1	4–5	9–10

c. Set slug screws of Z301, Z302, Z303, Z304, and Z305 to the approximate operating frequency as indicated by the following chart:

Frequency-position table

Core positions in 16ths of an inch	Final output in mc	Core positions in 16ths of an inch	Final output in mc
2	25. 0	8	37. 5
3	26. 5	9	40. 0
4	28. 0	10	45. 0
5	30. 0	11	48. 0
6	32. 5	12	50. 0
7	35. 0		

Note. Core position is measured from top of tension nut to top of slug screw.

d. Set the shaft slots on the front panel tuning controls to the approximate frequency (fig. 29).

e. Check all connections to see that the equipment is set up for local operation (par. 31).

f. Turn the MAIN POWER-ON-OFF switch on Electrical Equipment Cabinet CY–1221(*)/G to the ON position to apply power to the heating element of the crystal oven.

g. Turn the TRANSMITTER FREQ. 1-FREQ. 2-switch on Electrical Equipment Cabinet CY–1221(*)/G to the FREQ. 1 position.

h. Turn the COUPLING control and the COUP. SW. of the transmitter to their MIN positions.

i. Place the TUNE-OPERATE switch in the TUNE position.

j. Turn the TEST-OFF switch to the TEST position to apply power to the frequency 1 oscillator in the transmitter. Allow at least 15 minutes heating time before making any of the adjustments beginning in *k* below.

k. With the common terminal of the vtvm grounded to the chassis and the vtvm set to read negative direct current (dc) volts, place the test probe in jack J301. See figure 29 for location of this jack and all the following test points and tuning controls. Use an insulated alinement tool for all adjustments. Adjust the buffer V304 plate load impedance Z301 for maximum voltage. Nominal voltage is −20 volts dc.

l. Place the test probe in jack J302 and adjust first doubler plate load impedance Z302 for maximum indication on the vtvm. Nominal voltage is −30 volts dc.

m. Place the test probe in jack J303 and adjust second doubler plate impedance Z303 and third doubler grid load impedance Z304 for maximum indication on the vtvm. Nominal voltage is −27 volts dc.

n. Place the test probe in DR GRID test jack J304. Adjust DRIVER GRID TUNE capacitor C337 for maximum indication on the vtvm. Adjust Z305 for maximum indication on the vtvm. Some interaction between Z305 and C337 may be present, so that slight readjustment between the two may be necessary to obtain maximum indication on the vtvm. Nominal voltage at this stage is −63 volts dc.

o. Place the test probe in FIN GRID jack J305 and adjust FINAL GRID TUNE capacitor C345 and then DRIVER PLATE TUNE capacitor C343 for maximum indication on the vtvm. Nominal voltage is −40 volts dc.

p. Turn TEST-OFF switch to the OFF position.

Caution: High dc voltage is present on the PL CURRENT test jacks. Do not touch the meter case if it is metallic.

q. Connect a voltmeter (1,000 ohms per volt or better) across PL CURRENT test jacks J306 and J307; observe proper polarity. Set the voltmeter selector switch to read approximately 2.5 volts dc full scale. The meter so connected will represent 100 milliamperes (ma) plate current per volt indicated. For example, if the meter reads 2.1 volts, the plate current indicated is 210 ma.

r. Turn the TEST-OFF switch to the TEST position.

s. Adjust the FINAL PLATE TUNE control for minimum indication on the voltmeter.

t. Adjust the COUPLING control for maximum voltmeter indication. If no voltage rise is noted, rotate the COUP. SW. control one position clockwise toward MAX and repeat the adjustment of the COUPLING control.

u. Turn the TUNE-OPERATE switch to OPERATE and observe the voltmeter reading.

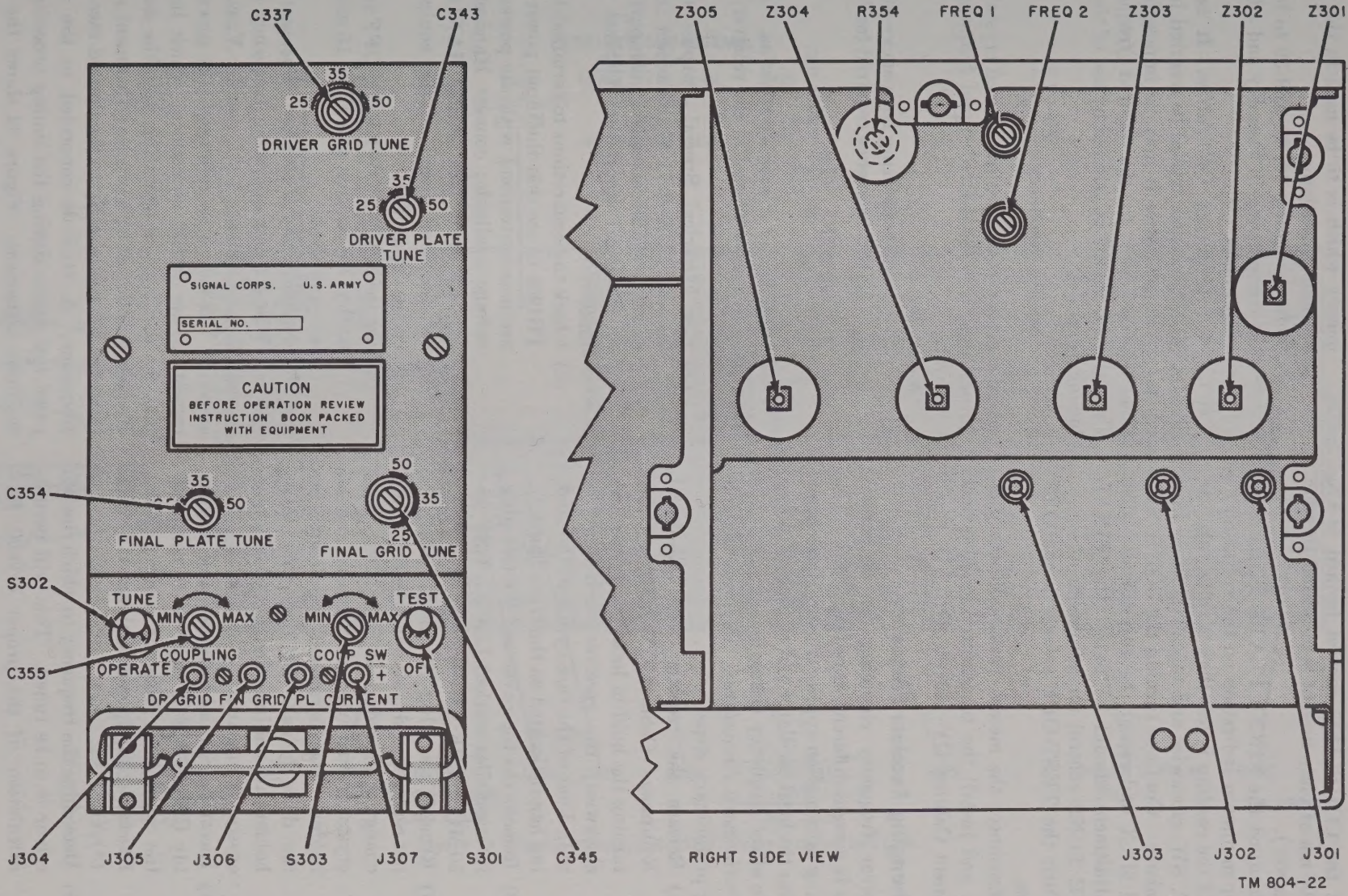

Figure 29. Radio Transmitter T-417/GR, alinement points.

Adjust the COUPLING control toward MAX until 200 ma of plate current is indicated (2 volts dc on meter).

v. Readjust the FINAL PLATE TUNE control for minimum indication on the voltmeter.

w. If the reading is less than 2 volts, turn the COUP. SW. clockwise and repeat the steps in *u* and *v* above. Continue turning the COUP. SW. toward MAX and repeat the adjustments. The last adjustment should be to set the FINAL PLATE TUNE control for minimum.

x. Turn the TEST-OFF switch to the OFF position.

y. Disconnect the meters, reassemble the dust covers, and install the transmitter in Electrical Equipment Cabinet CY–1221(*)/G.

38. Changing Receiver Frequency

Receiver frequency changing can be accomplished in several different ways (par. 35*a*). The following information applies when it is necessary to realine the local oscillator and rf plug-in tuning units to effect frequency changing.

a. Preliminary Procedures. Perform the following preliminary steps:

(1) Release the receiver from Electrical Equipment Cabinet CY–1221(*)/G by turning the hold-in lock handle counterclockwise; the receiver then may be pulled out of the case by use of the folding handle located on the front panel.

(2) Remove the top cover and the two plug-in assemblies marked LOCAL OSC 25–50 MC and RF AMPL 25–50 MC.

(3) Remove the plug-in unit shields. Do not replace the shields until the frequency changing procedure is completed. The crystal frequency is marked on the crystal holder. The thermostat is indicated by the dark holder. Be sure that these holders are not interchanged when a new crystal is inserted.

(4) Electrical Special Purpose Cable Assembly CX–2371/U is required to complete the connections from the receiver to the Electrical Equipment Cabinet CY–1221 (*)/G.

(5) Determine the frequency to which the receiver is to be tuned. This will permit calculation of the proper crystal frequency which is to be used in the high frequency oscillator.

(6) Refer to figures 30, 31, and 32 to locate the correct plug-in assembly and adjustment points.

b. Crystal Frequency Calculation. It is important that the proper crystal be inserted in the crystal oven; otherwise it may be impossible to tune the oscillator to the desired frequency. Crystal Y231 should be selected by use of the following formula:

$$\text{crystal frequency} = \frac{Fr + 7.8}{2}$$

where *crystal frequency* is the desired crystal frequency and Fr is the desired signal frequency in megacycles.

Example:

Fr = desired operating frequency = 40 mc.

Fx = crystal frequency required for Fr.

$$Fx = \frac{40 + 7.8}{2} = \frac{47.8}{2} = 23.9 \text{ mc.}$$

c. Connections and Power Application. After installing the proper crystal in the receiver, proceed as follows:

(1) Use Electrical Special Purpose Cable Assembly CX–2371/U to connect the receiver to the Receiver No. 1 compartment of Electrical Equipment Cabinet CY–1221(*)/G.

(2) Check the connections to terminal board TB1904 to see that the input power connections correspond with the power line voltage available; connect Handset H–33D/PT to the jack marked HANDSET on the front panel of the equipment cabinet (par. 31).

(3) Set the MAIN POWER ON-OFF switch to the ON position and allow 15 minutes warmup time.

d. Hf Oscillator and Multiplier Alinement Procedure. When a new operating frequency is required, the hf oscillator V231, doubler V232, and amplifier V233 must be retuned. The procedure consists of an initial adjustment which insures that the oscillator is operating near the desired frequency, followed by a precise adjustment which tunes the receiver exactly to the desired incoming frequency. A vtvm is connected to the front panel test points during the tuning procedure to facilitate alinement. Figure 32 shows the loca-

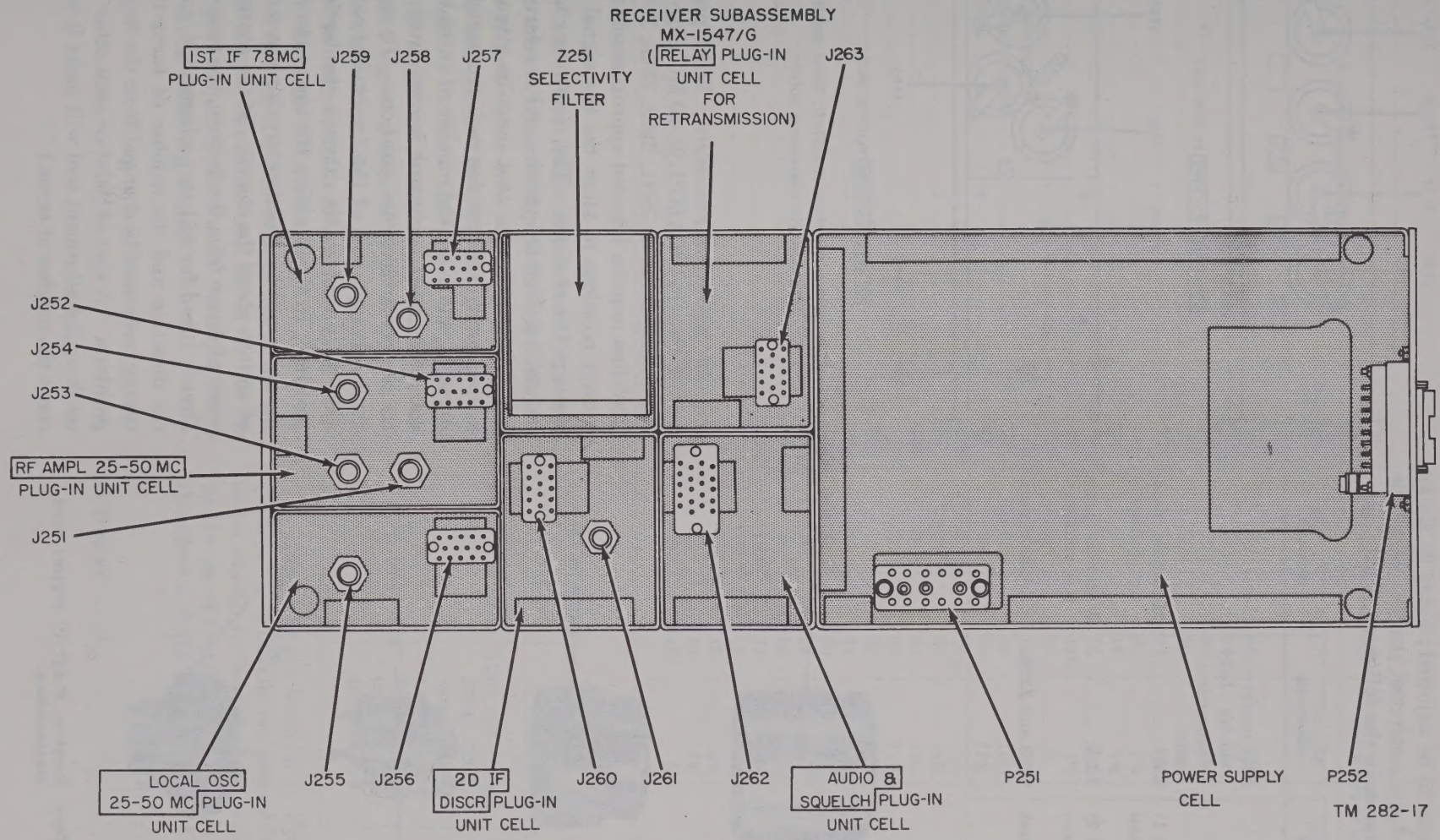

Figure 30. Radio Receiver R-257/U, compartment location.

tion of the items to be adjusted; figure 38 shows the location of the meter test points. Make the adjustments shown in the following chart:

Vtvm connection	Adjustment	Indication
None	Z231 unscrewed almost fully counterclockwise.	None.
R231 (test point 1) on TB231 and GND.	Z231	Maximum negative voltage.
R239 (test point 2) on TB231 and GND.	Z232	Maximum negative voltage.
L. O. and GND test points.	Z233 and Z234	Maximum negative voltage.

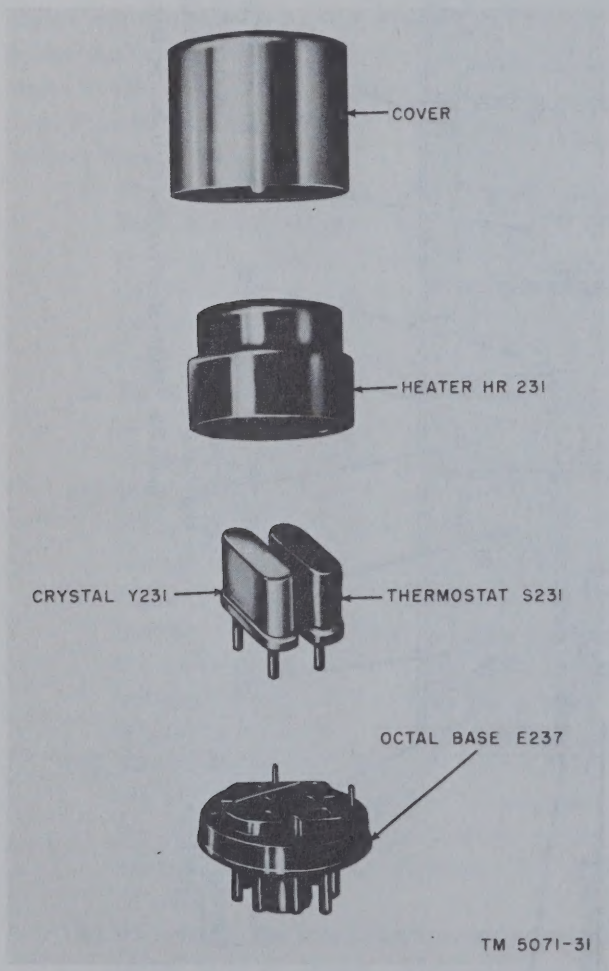

Figure 31—Radio Receiver R–257/U, crystal oven, disassembled.

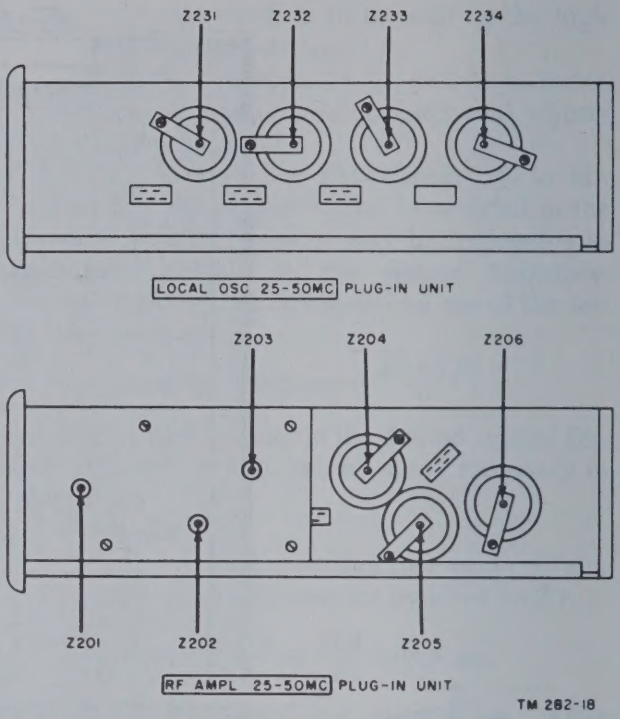

Figure 32. Radio Receiver R–257/U, local oscillator and rf amplifier alinement points.

e. RF Alinement Procedure. When presetting tuning cores in RF AMPL 25–50 MC plug-in unit, the tuning cores of Z201, Z202, Z203, Z204, and Z205 first must be adjusted approximately to their correct positions to allow the test signal to pass through the rf stages. The following chart lists various receiver frequencies and the corresponding number of turns that must be given to the tuning cores to adjust for each frequency. Columns 2, 3, and 4 list the number of turns that the core slugs must be turned *inward* from the extreme counterclockwise positions. To use these three columns, each of the five tuning cores first must be turned to its extreme counterclockwise position. In this position, the top of the core adjusting screw is approximately thirteen-sixteenths of an inch above the chassis. If the equipment is received direct from the factory, the receivers are already tuned for 34.1 mc; columns 5, 6, and 7 list the direction and the number of turns that the tuning cores must be changed from the factory-set positions. (A spot of paint or some other type of mark on the alinement tool will make it easier to count the number of turns.)

1	2	3	4	5	6	7
Receiver frequency (mc)	Number of clockwise turns of tuning cores			Number of clockwise turns of tuning cores from factory-set position (34.1 mc)		
	Z201, Z202, and Z204	Z203	Z205	Z201, Z202, and Z204	Z203	Z205
25	28½	26½	30	18¼	18½	17
26	26¼	24½	28	16	16½	15
27	24	22½	26	13¾	14½	13
28	22	20½	20	11¾	12½	11
29	20	18½	22	9¾	10½	9
30	18	16½	20	7¾	8½	7
31	16	14	18	5¾	6	5
32	14	12	16	3¾	4	3
33	12	10	14½	1¾	2	1½
34	10¼	8	13	0	0	0
35 (with jumpers)	9½	7½	12½	*¾	*½	*½
35 (without jumpers)	29	28	33	18¾	20	20
36	27	26	30	16¾	18	17
37	27½	24½	27½	15¼	16½	14½
38	24	23	26	13¾	15	13
39	22¾	21½	24½	12½	13½	11
40	21½	20	23	11¼	12	10
41	20¼	19	22	10	11	9
42	19¼	18	21	9	10	8
43	18¼	17	20	17	9	7
44	17¼	16	19	16	8	6
45	16	15	18	5¾	7	5
46	14¾	13¾	17	4½	5¾	4
47	13¾	13	16	3½	5	3
48	13	12	15	2¾	4	2
49	12	11	14	1¾	3	1
50	10¾	9½	13	½	1½	0

*Counterclockwise.

f. Rf and First Mixer Alinement Procedure. Rf and mixer stages V201, V202, and V203 can now be alined to the new signal frequency. A vtvm is used at the receiver test points on the front panel to facilitate alinement. The signal to which the stages are tuned is provided by an unmodulated signal generator with an output impedance of 50 ohms. Set the signal generator output to 20 microvolts. Disconnect Cord CG–399A/U from the TRANS and REC. No. 1 ANTENNA terminals on the rear of the equipment antenna coaxial connector and set it to the desired signal frequency, then make the adjustments shown in the following chart:

Vtvm connection	Adjustment	Indication
2ND IF and GND.	Z201, Z202, Z203, Z204, Z205 in sequence. Repeat adjustments at least 3 times in sequence.	Maximum negative voltage.

g. Adjusting the Receiver to Transmitter Frequency. It is usually not possible to aline the receiver exactly to the distant transmitter frequency by the use of a signal generator alone (par. 35*d*); therefore a slight readjustment of the crystal os-

cillator circuit is necessary to precisely aline the receiver with a signal from the distant transmitter. The procedure is as follows:

(1) Place the receiver in operation as described in *c* above. Make sure that the distant transmitter is operating on the desired signal frequency. The radio set must be connected to an antenna for this adjustment.
(2) Connect a vtvm to the front panel test points marked DISCR and GND.
(3) Readjust oscillator warping coil Z231 for a +1 volt reading on the vtvm.
(4) Replace the plug-in unit shields and reinsert the plug-in units in the receiver base assembly.
(5) Remove Electrical Special Purpose Cable Assembly CX–2371/U and install the receiver in the equipment cabinet.
(6) This completes the receiver frequency changing procedure.

h. Crystal Adjustment. It is possible to *warp* the crystal to a frequency considerably lower than its natural resonant frequency. Under these conditions, some crystals may not oscillate once the receiver is turned off and later turned on. As a precaution against this condition, turn the receiver off and on at least once after the final adjustment of the LOCAL OSC 25–50 mc plug-in unit. If the oscillator fails to function after this test, replace crystal Y231 with one that operates satisfactorily.

CHAPTER 3

OPERATION

Section I. CONTROLS AND INSTRUMENTS

39. Controls and Their Uses

Haphazard or improper setting of the controls on any one unit can cause damage to the associated system equipment. Metering circuits, functional switching controls, and power circuits are normally completed through several system components. For this reason, it is important to know the functions of the front panel controls on all units. Paragraphs 39 through 45 list these front panel controls and indicate the functions of each.

40. Electrical Equipment Cabinet CY–1221(*)/G Controls

(fig. 33)

Control	Function
MAIN POWER ON-OFF switch and pilot lamp (S1903).	Controls power from ac source to transmitter power supply and receiver power supplies. Pilot lamp is lighted when power switch is in ON position and Receiver No. 1 is installed.
INTERCOM. ON-OFF switch (S1906).	INTERCOM. ON-OFF switch controls communication between radio set and remote control unit (Radio Set Control C–845/U). Switch is spring-loaded in OFF position. In ON position, it is possible to communicate with remote unit; however, transmitter is disabled. In OFF position, transmitter operates when either handset switch is closed.
TRANSMITTER FREQ. 1-FREQ. 2-switch (S1902).	In FREQ. 1 position, switch selects transmitter frequency 1 and selects alternate frequency in FREQ. 2 position when equipment is set for local operation (par. 31).
REC. 1-SQUELCH control (S1905).	Sets threshold sensitivity of REC. 1 squelch circuit. In OFF position, a switch disables squelch circuit.
REC. 2-SQUELCH control (S1904).	Sets threshold sensitivity of REC. 2 squelch circuit. In OFF position, a switch disables squelch circuit.
CONTROL UNIT POWER ON-OFF switch (S1901).	Not used in Radio Set AN/FRC–15.
HANDSET jack (J1907).	Handset H–33D/PT connects to this jack.

41. Radio Transmitter T–417/GR Controls

(fig. 34)

Control	Function
TEST-OFF switch (S301).	In TEST position, switch energizes relay in external power supply to provide power for transmitter. In OFF position, power is applied to transmitter by action resulting from operation of push-to-talk switch of Handset H–33D/PT.
TUNE-OPERATE switch (S302).	In TUNE position, screen grid voltage of driver and power output amplifier tubes is reduced. In OPERATE position, normal screen grid voltage is applied and maximum output is obtained.
DRIVER GRID TUNE control (C337).	Tunes driver grid tank circuit to resonance with signal from 3d doubler stage.
DRIVER PLATE TUNE control (C343).	Tunes 4th doubler and driver tank circuit to resonance at 16 times crystal frequency.
FINAL GRID TUNE control (C345).	Tunes grid tank circuit of power amplifier tubes V309 and V310 to resonance.
FINAL PLATE TUNE control (C354).	Tuning control for power amplifier plate tank circuit.

Control	Function
MIN-MAX COUPLING control (C355).	Provides fine adjustments of coupling between plate tank and filter network.
MIN-MAX COUP. SW. control (S303).	Coarse control of coupling adjustments in conjunction with C355.
DR. GRID jack (J304).	Test point for checking grid voltage during tuning of the 3d doubler plate circuit and driver/doubler grid circuit.
FIN. GRID jack (J305).	Test point for checking grid voltage of power amplifier during tuning procedure.
PL. CURRENT jacks (J306 and J307).	Test points for checking plate current of power amplifier stage during tuning procedure.

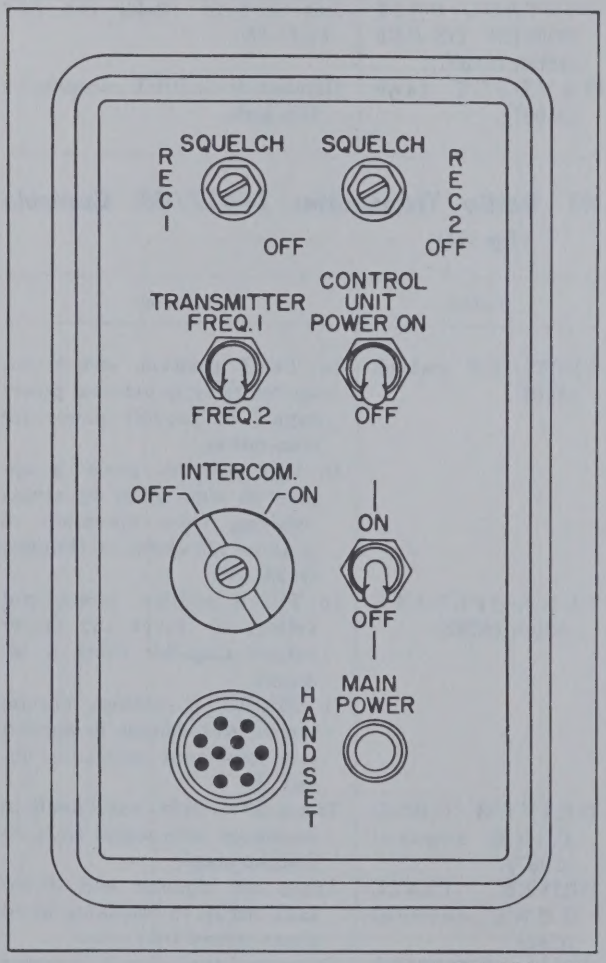

Figure 33. Electrical Equipment Cabinet CY–1221(*)/G, controls.

42. Radio Set Control C–844/U

(fig. 35)

Control	Function
Line input (AT701)	Screw driver control behind front panel which is accessible through a hole. Used to set audio level to transmitter modulator, when a remote handset microphone is operated.
Test points	Functions of test points are as follows: 1. Ground. 2. For checking 160 volts for operations of frequency change relay. 3. For checking audio level to modulator. 4. For checking audio level from remote position.

43. Radio Set Control C–845/U Controls

(fig. 36)

Control	Function
LINE LEVEL meter (M2601).	Indicates outgoing audio signals across 600-ohm line. Scale indicates from −10 to +6 db. Red line marks −2db reading to facilitate setting audio level to correct voltage.
POWER pilot lamp (I 2602).	Lights when power is being supplied to control.
TRANSMIT lamp (I 2601).	Lights when push-to-talk handset switch is closed.
HANDSET jack (J2601).	Handset H–33D/PT connects to this jack.
Frequency selector-intercom switch (S2602).	This three-position switch performs following functions: In FREQ. 1 REC. 1 position, selects transmitter frequency 1, and connects audio from Receiver No. 1 to audio amplifier circuit of remote control unit. In INTERCOM position, allows intercommunication between local and remote positions. In FREQ 2 REC. 1 and 2 position, selects transmitter frequency 2 and connects audio from Receivers 1 and 2 to audio amplifier circuit of remote control unit.

Control	Function
MICROPHONE LEVEL control (R2633).	Adjusts handset microphone level to audio line to maintain proper modulation at transmitter.
SPEAKER VOLUME-OFF switch (S2603).	Consists of two ganged sections. One section controls application of power to remote control power supply; other section varies speaker and handset volume level in four steps.
SPEAKER ON-OFF Switch (S2604).	This toggle switch allows operator to mute speaker as desired by placing switch in OFF position. Switch is spring-loaded in the ON position.
TONE switch (S2601).	When TONE switch is pressed, tone signal of 1,000 cps is sent through the amplifier. It can be used to attract attention at distant radio station or to test remote control unit for proper operation and to set audio level to the transmitter. Switch is spring-loaded in off (up) position.

44. Power Supply PP–804/U Controls
(fig. 37)

Control	Function
115–230 switch (S601).	Voltage changeover switch is located under right side cover. In 115 position, power supply is set up to operate from 115 volts, 50 to 65 cps ac. In 230 position, power supply is set to operate from 230 volts, 50 to 65 cps ac.
Test points.	Functions of front panel test points are as follows: For checking 1.35-volt filament voltage. For checking —25-volt bias. For checking 225-volt screen voltage. For checking 500-volt plate supply.

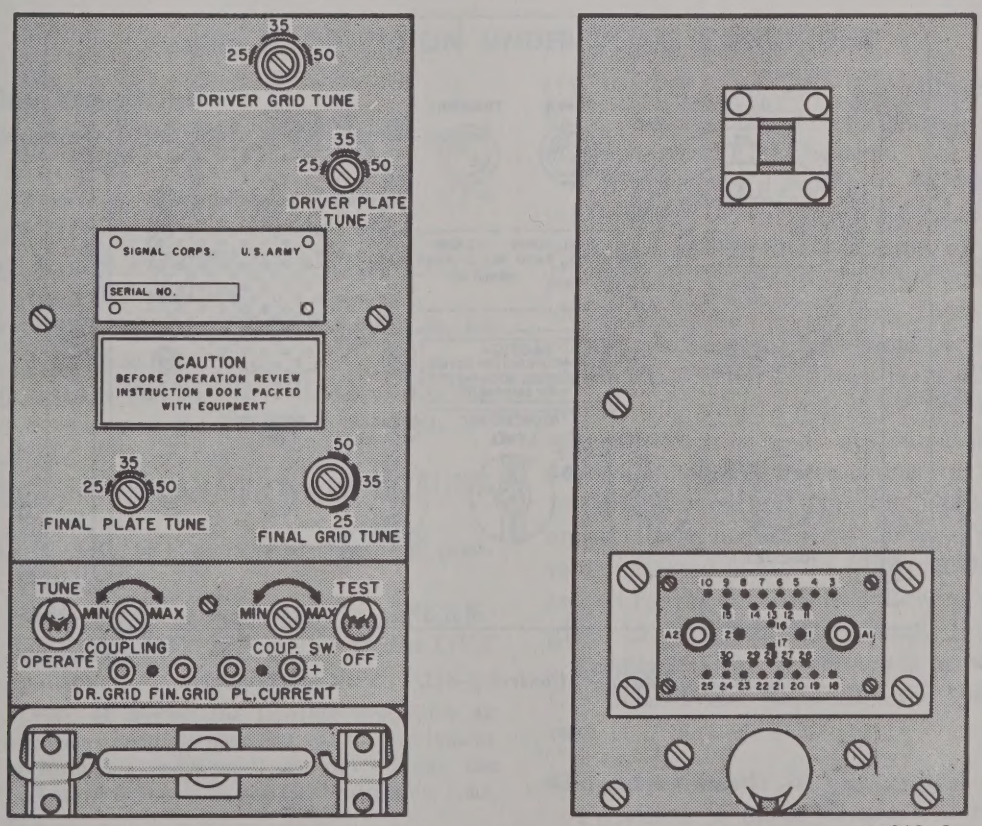

Figure 34. Radio Transmitter T–417/GR, front panel controls and connecting plug.

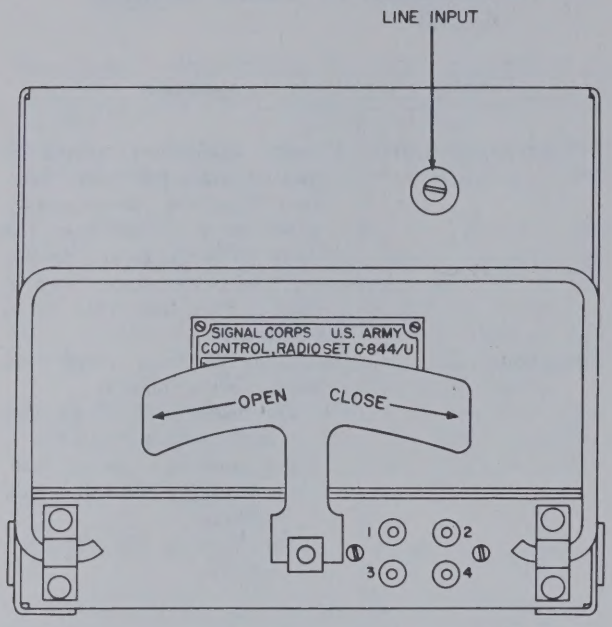

Figure 35. Radio Set Control C–844/U, front panel control.

45. Radio Receiver R–257/U Test Points

(fig. 38)

Test point	Function
L. O	Jack to measure dc voltage at control grid of 1st mixer tube V203.
RF	Jack to measure dc voltage at control grid of 7.8-mc amplifier tube V51.
1st If	Jack to measure dc voltage at control grid of 1st 455-kc amplifier tube V81.
2d If	Jack to measure dc voltage at control grid of 5th 455-kc amplifier tube V85.
DISCR	Jack to measure dc output of discriminator circuit.
FIL	Jack to check 1.4-volt dc filament.
B+	Jack to check +145-volt dc plate supply voltage.
GND	Provides common ground connection for external meter measurements.

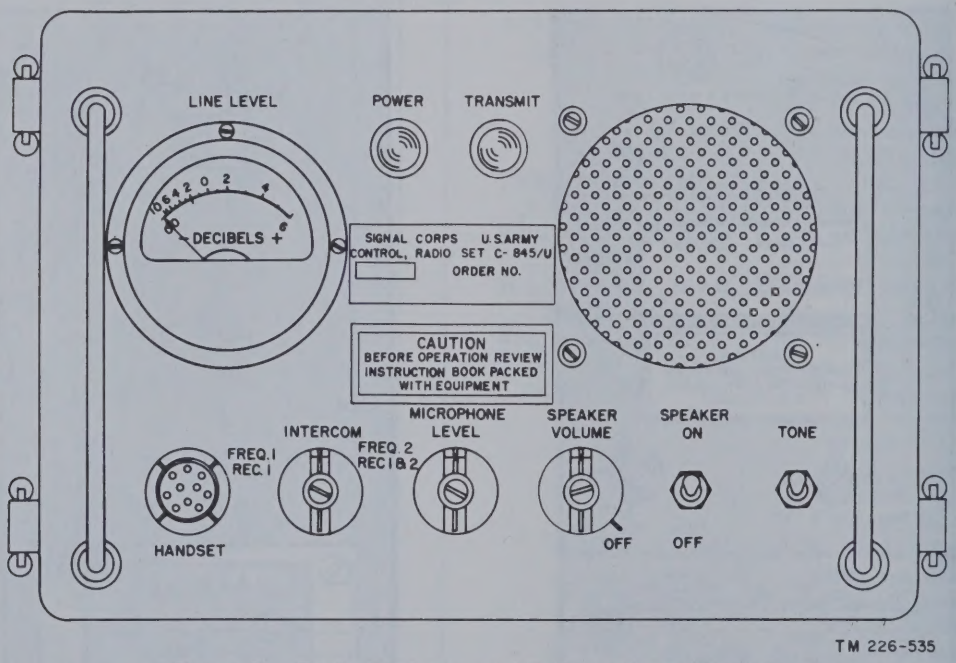

Figure 36. Radio Set Control C–845/U, front panel controls.

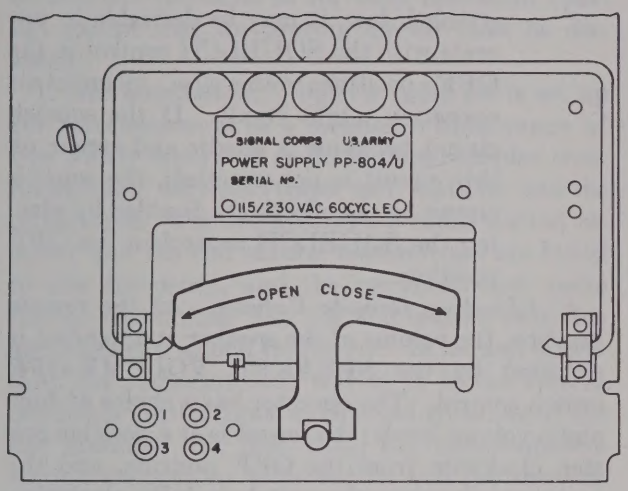

Figure 37. Power Supply PP–804/U, controls.

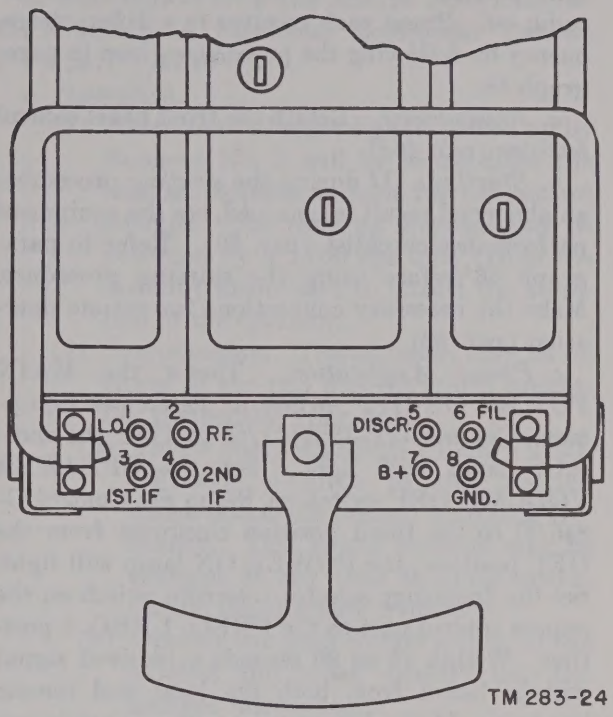

Figure 38. Radio Receiver R–257/U, front panel test points.

Section II. OPERATION UNDER USUAL CONDITIONS

46. Tuning Procedures

a. Preliminary. Set equipment front panel controls as follows:

(1) *Electrical Equipment Cabinet CY–1221(*)/G.*
- (*a*) MAIN POWER-ON-OFF switch in the OFF position.
- (*b*) INTERCOM.-ON-OFF switch in the OFF position.
- (*c*) TRANSMITTER FREQ. 1-FREQ. 2 switch in the FREQ. 1 position.

(2) *Radio Transmitter T–417/GR.*
- (*a*) TUNE-OPERATE switch in TUNE position.
- (*b*) TEST-OFF switch in the OFF position.

(3) *Radio Set Control C–845/U.* SPEAKER VOLUME-OFF switch in the OFF position.

Note. If during the starting procedure an abnormal result is obtained, see the equipment performance checklist (par. 69). Make the necessary connections for local operation (par. 31).

b. Starting. Throw the MAIN POWER-ON-OFF switch in the Electrical Equipment Cabinet CY–1221(*)/G to ON. The indicator lamp will light. Set the TEST-OFF switch on the transmitter to the TEST position.

c. Transmitter Tuning Adjustments. The transmitter output tuning controls may require readjustments at the beginning of an operating period if the transmitter output power has fallen off appreciably. To perform these adjustments, connect a voltmeter (1,000 ohms per volt or better) across PL. CURRENT test jacks J306 and J307; observe the proper polarity. Set the voltmeter selector switch to read approximately 2.5 volts dc full scale. The meter so connected will represent 100-ma plate current per volt indicated. For example, if the meter reads 2.1 volts, the plate current indicated is 210 ma. Adjust the transmitter output tuning controls by following the procedure given in paragraph 27*s* through *y*.

Caution: High dc voltage is present on the PL CURRENT test jacks. Do not touch the meter case if it is metallic.

47. Adjustments for Reception

Provision is made to use two receivers with Radio Set AN/FRC–15. If a second Radio Receiver R–257/U is procured, operate it in the

same manner as the receiver supplied with the radio set. Preset each receiver to a different frequency by following the procedure given in paragraph 38.

a. Preliminary. Retain the front panel control settings (par. 46*a*).

b. Starting. If during the starting procedure, an abnormal result is obtained, see the equipment performance checklist (par. 69). Refer to paragraph 46 before using the starting procedure. Make the necessary connections for remote operation (par. 32).

c. Power Application. Throw the MAIN POWER ON-OFF switch in Electrical Equipment Cabinet CY–1221(*)/G to ON; the indicator lamp will light. Set the SPEAKER VOLUME-OFF switch on Radio Set Control C–845/U to the third position clockwise from the OFF position; the POWER ON lamp will light. Set the frequency selector-intercom switch on the remote control unit to the FREQ. 1 REC. 1 position. Within 15 or 20 seconds a received signal will be heard from both the local and remote handsets. If the distant transmitter is not in operation, a rushing noise will be heard instead. There is no front panel control for adjusting the receiver volume to the local handset.

d. Adjusting Squelch. When the SQUELCH control is in the OFF position, the receiver cannot be squelched. This permits the receiver to receive any strength signal without cutting off the audio output. The squelch can be adjusted to mute the receiver output when a weak signal or no signal is being received. The setting at which this occurs is called the squelch threshold level. Adjust the SQUELCH control as follows:

(1) Turn the SQUELCH control to its fully clockwise position (not OFF) and note whether a signal or only noise is being received.

(2) At an interval when no signal is heard, advance the SQUELCH control counterclockwise until the background noise disappears, *but no further.* Wait for a signal to come on. If possible, order a signal from a transmitter several miles away.

(3) The signal should unsquelch the receiver during the period of transmission from the other station. The receiver should squelch as soon as the signal from the transmitter is shut off.

(4) If the receiver does not squelch at this point, it may be necessary to advance the squelch control slightly counterclockwise. When the noise level is high, and signal strength low, it may be desirable to operate with the SQUELCH control in the OFF position; otherwise inconsistent operation might result. If the squelch circuit behavior is erratic and repair on this circuit is not practical, the squelch circuit can be effectively disabled by placing the SQUELCH control in the OFF position.

e. Adjusting Remote Volume. At the remote position, the volume of the speaker and handset is adjusted by the SPEAKER VOLUME-OFF switch control. The operator has a choice of four audio volume levels; the lowest is at a position one step clockwise from the OFF position, and the maximum is when the switch is fully clockwise. Set the switch for a comfortable listening level.

48. Types of Operation

Radio Set AN/FRC–15 provides reception and transmission of fm signals from either a local or remote position, or it may be used for retransmission of signals between two widely separated stations. In addition, a tone signal is available from the remote position for the purpose of signaling and for adjusting the equipment.

a. Simplex Operation. When the radio set is set up with only one antenna, operation is limited to communication in one direction at a time. Reception and transmission may be carried out on two different frequencies, although operation on a single frequency is more usually done. Simplex operation can be performed from the local or the remote position. For connections, refer to paragraphs 31 and 33.

b. Duplex Operation. When the radio set is set up with two antennas, two-way simultaneous communication is possible as in a telephone conversation. Duplex operation is possible from the local position only and requires that the receiver and transmitter frequencies be different. For duplex operation, install the receiver in the Receiver No. 2 position so that the second antenna is connected to the receiver. Make sure there is no jumper connection between terminals 1 and 2 of terminal board TB1901; otherwise the receiver will be automatically muted when transmission begins. Also make sure that a jumper is con-

nected between terminals 8 and 9 on TB1902; this connection applies the receiver audio output to the local handset. The connections for duplex operation are the same as for local operation (par. 31) except that the muting circuit must be disabled.

c. Retransmission. When a radio set is set up for retransmission in a location within range of two widely separated radio stations, simplex communication between these end stations can be established. The retransmission radio station receiver and the end station transmitters are tuned to one frequency, and the retransmission radio station transmitter and the end station receivers are tuned to a second frequency. In normal operation, the retransmission station is in the receive condition until a signal is received from one of the end stations. At that time, the retransmission station transmitter is turned on and the receiver output of the retransmission station is applied to the transmitter modulator input. The transmitter then retransmits the signal on the second frequency so that the signal may be received by the other end station receiver. Connections for retransmission are given in paragraph 33. The end stations may be operated from the local or the remote position. Connections for local operation are given in paragraph 31, connections for remote operation are given in paragraph 32, and connections for retransmission are given in paragraph 33.

49. Local Operation

Connections for local operation are given in paragraph 31.

a. Preliminary. Set equipment front panel controls as follows:

(1) *Electrical Equipment Cabinet CY–1221 (*)/G.*

(*a*) MAIN POWER-ON-OFF switch at OFF position.

(*b*) INTERCOM. ON-OFF switch at OFF position.

(*c*) TRANSMITTER-FREQ. 1 FREQ. 2-switch at FREQ. 1 position. To operate at the alternate transmitter frequency, set the switch to the FREQ. 2-position.

(2) *Radio Transmitter T–417/GR.*

(*a*) TUNE-OPERATE switch in the OPERATE position.

(*b*) TEST-OFF switch in the OFF position.

b. Starting. Throw the MAIN POWER-ON-OFF switch in Electrical Equipment Cabinet CY–1221(*)/G to ON.

c. Operation.

(1) *Reception.* Distant signals picked up by Receiver No. 1 will be heard from the handset earpiece without further control settings. The received message may be preceded by a 1,000 cps tone (from the distant transmitter) to attract the attention of the operator.

(2) *Transmission.* Transmission may be on either of the two predetermined operating frequencies (par. 36).

(*a*) Throw the TRANSMITTER-FREQ. 1-FREQ. 2-switch to the position which selects the desired operating frequency. This switch position may be changed at any time to allow operation on the alternate frequency.

(*b*) Operate the push-to-talk switch of the handset and speak directly into the handset microphone.

(3) *Retransmission.* Refer to paragraph 33 for proper connections. Retransmission of received signals will be automatic upon the completion of these connections. The received signals may be monitored at the local handset.

50. Remote Operation

Connections for remote operation are given in paragraph 32.

a. Preliminary. Set equipment front panel controls as follows:

(1) *Electrical Equipment Cabinet CY–1221 (*)/G.*

(*a*) MAIN POWER-ON-OFF switch in the ON position.

(*b*) INTERCOM. ON-OFF switch in the OFF position.

(2) *Radio Transmitter T–417/GR.*

(*a*) TUNE-OPERATE switch in the OPERATE position.

(*b*) TEST-OFF switch in the OFF position.

(3) *Radio Set Control C–845/U.*

(*a*) Frequency selector-intercom switch in the FREQ. 1 REC. 1 position. To operate at the alternate transmitter frequency, set the switch to the FREQ. 2-REC. 1 and 2 position. This will

automatically switch the No. 2 receiver (if one is installed) in the operating circuit.

(*b*) SPEAKER VOLUME-OFF switch in the OFF position.

b. Starting. The following operations are performed at remote Radio Set Control C–845/U:

(1) Turn the SPEAKER VOLUME-OFF switch in a clockwise direction. Within 15 or 20 seconds radio signals received at the local position will be heard from the speaker at the remote operation position.

(2) Transmission from the remote position depends only on the push-to-talk operation of Handset H–33D/PT.

c. Reception.

(1) Set the frequency selector-intercom switch to the FREQ. 1 REC. 1 position. Signals picked up by Receiver No. 1 at the local position will be heard from the loudspeaker and from the handset.

(2) Set the SPEAKER VOLUME-OFF control to obtain a comfortable listening level.

(3) Hold the SPEAKER ON-OFF switch down to mute the loudspeaker.

(4) Set the frequency selector-intercom switch to the FREQ. 2 REC. 1 and 2 position for reception of signals from Receivers No. 1 and No. 2.

d. Parallel Operation. Two or more Radio Set Control C–845/U units can be connected in parallel for monitoring purposes. When this is done, operate the frequency selector switch on one unit only. The second unit will then receive the signals selected by the first unit.

e. Transmission.

(1) Set the frequency selector-intercom switch to the FREQ. 1 or the FREQ. 2 position, depending on the choice of operating frequency (par. 36).

(2) Simultaneously operate the TONE switch (spring-loaded) and the push-to-talk switch of the handset. This action will modulate the transmitter with a 1,000-cps tone for the purpose of attracting the attention of the operator at the distant receiving station.

(3) Release the TONE switch and speak into the handset microphone at a normal voice level.

(4) Set the MICROPHONE LEVEL control so that average voice peaks read −2 decibels (db). This is to the red line on the LINE LEVEL meter. The modulation level of the transmitter will be correct at this setting, and messages from the remote position will be properly transmitted.

f. Intercommunication. Intercom operation between the remote and local positions can be initiated by the local operator only. Once established, intercommunication can proceed in one direction at a time; that is, one operator cannot talk until the other operator releases his handset push-to-talk switch. In addition, the spring-loaded INTERCOM. ON-OFF switch at the local position must be held in the ON position during intercom operation. To effect intercommunication between the two positions, proceed as follows:

(1) At the local position, hold the INTERCOM ON-OFF switch to the ON position, press the push-to-talk switch on the local handset, and call the remote operator.

(2) The local operator will be heard at the remote loudspeaker or handset if the remote handset push-to-talk switch is released; the frequency selector-intercom switch may be in any position.

(3) To talk from the remote position, set the frequency selector-intercom switch to INTERCOM, wait for the local operator to release his handset push-to-talk switch, press the remote handset push-to-talk switch and talk to the local operator. The local operator must hold the INTERCOM ON-OFF switch in the ON position.

(4) Intercommunication between two Radio Set Control C–845/U units connected in parallel can be accomplished by placing the frequency selector-intercom switch of each unit in the INTERCOM position. The operators must then press the push-to-talk switch to talk and release it to receive.

51. Stopping

a. Local Operation. Throw the MAIN POWER-ON-OFF switch of Electrical Equipment Cabinet CY–1221(*)/G to the OFF position.

b. Remote Operation.

(1) Establish intercommunication between the local and remote positions (par. 50*f*). Instruct the remote operator to set the SPEAKER VOLUME-OFF switch of Radio Set Control C–845/U to the OFF position.

(2) Throw the MAIN POWER-ON-OFF switch of Electrical Equipment Cabinet CY–1221(*)/G to the OFF position.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

52. General

The operation of Radio Set AN/FRC–15 may be difficult in regions where extreme cold, heat, humidity, moisture, and sand conditions prevail. Procedures for minimizing the effects of these unusual operating conditions are given in paragraphs 53 through 56.

53. Antijamming

When the receiver is jammed, follow the procedures listed below until the transmitted signal is heard again.

a. Set the frequency-selector-intercom switch to the position which gives the best signal.

b. Adjust the SQUELCH control for maximum receiver sensitivity.

c. Advance the volume control for maximum volume.

d. If the procedures given in *a*, *b*, and *c* above are not successful, try any or all of the following:

(1) Change the direction, position, or height of the antenna.

(2) Relocate the equipment so that some object such as a tank, truck, or tree is between the jamming source and the equipment.

(3) Request a frequency change.

e. If the jamming action prevents communication, use some other means of getting the message through.

f. Continue to operate so that the enemy will be uncertain of his jamming success.

54. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the equipment carefully.

b. Keep the equipment warm and dry. If no heat is provided in the building or shelter, keep the filaments of the vacuum tubes lighted continuously, unless this overtaxes the power supplies.

c. Be careful to prevent cold air from coming in contact with heated tubes when the door is open. A sudden draft of cold air may shatter the glass envelope of a heated tube. This is especially true of the driver and output stage tubes of Radio Transmitter T–417/GR.

d. Heavy coatings of frost will gather on the microphone mouthpiece in Handset H–33D/PT in extreme cold weather when the handset is used outdoors or in a cold room. Most of the handsets are protected by a thin rubber or plastic membrane; in some cases, the frost will be heavy enough to cause inefficient or no operation. Plastic covers have been designed to protect some types of microphones or handsets. Use them if they are available. Have a spare handset ready, if possible, in case the one in use fails to function properly.

e. The equipment will sweat until it is brought up to room temperature after exposure to cold. This condition also arises when the equipment is used after exposure during a cold night. When the equipment has reached room temperature, dry it thoroughly.

55. Operation in Tropical Climates

a. When operating equipment in tropical climates, high relative humidity will cause condensation of moisture on the equipment whenever the equipment temperature becomes lower than that of the surrounding air. To minimize this condition, place lighted electric bulbs under the equipment. Dry the equipment thoroughly before operating it.

b. Tape all cable connectors with rubber tape to prevent shorts and leakage by moisture.

56. Operation in Desert Climates

a. Conditions similar to those in tropical climates often prevail in desert areas. Use the same measures to insure proper equipment operation.

b. The main problem that arises with equipment operation in desert areas is the large amount of sand, dust, and dirt that enters the moving

parts of the radio equipment, such as the blower. If possible, house the equipment in a dustproof shelter. Because such a building is seldom available and would require air conditioning, the next best precaution is to make the shelters as dustproof as possible, with available materials. Hang wet sacking over the windows and doors.

c. Be sure to keep the equipment as free from dust as possible. Make frequent preventive maintenance checks.

d. Make periodic checks of the antenna installation to prevent antenna and transmission line damage during the sudden wind squalls which occur in desert areas.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. ORGANIZATIONAL TOOLS AND TEST EQUIPMENT

57. General

One alinement tool and five Allen wrenches are issued with Radio Set AN/FRC–15. Tool Equipment TE–41 contains tools suitable for organizational maintenance. In addition, a multimeter (Multimeter TS–297/U or equal) and a tube tester (Electron Tube Test Set TV–7/U or equal) are required.

58. Special Cable Issued With Equipment

A special cable is available to connect the receiver, transmitter, or power supply to Electrical Equipment Cabinet CY–1221(*)/G when it is necessary to operate them outside the case. Electrical Special Purpose Cable Assembly CX–2371/U (fig. 39) has a male connector on one end and a female connector on the other end. It is useful when troubleshooting the equipment because it allows internal measurements to be made on the equipment when the set is operated outside the case. The cord can be used with all four units because the pin connections of the rear panel connectors are identical.

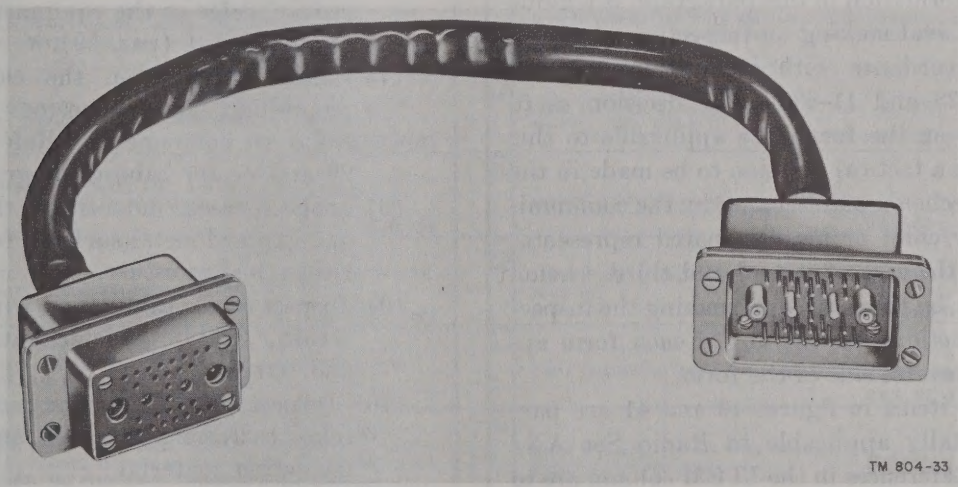

Figure 39. Electrical Special Purpose Cable Assembly CX–2371/U.

Section II. PREVENTIVE MAINTENANCE SERVICES

59. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair because its object is to prevent certain troubles from occurring.

60. General Preventive Maintenance Techniques

a. Use No. 000 sandpaper to remove corrosion. Never use steel wool.

b. Use a clean, dry lint-free cloth or dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with

solvent, dry cleaning (SD); then wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a cloth.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch (psi) to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 178, Preventive Maintenance Guide for Radio Communication Equipment.

61. Use of Preventive Maintenance Forms (figs. 40 and 41)

a. The information in this paragraph is a guide to the individual making an inspection of equipment, in accordance with instructions on DA Forms 11–238 and 11–239. The decision as to which items on the forms are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 40 and 41 are partially or totally applicable to Radio Set AN/FRC–15. References in the ITEM column are to paragraphs in the text which contain additional maintenance information.

62. Performing Preventive Maintenance

a. Performing Exterior Preventive Maintenance.

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

(1) Check for completeness and satisfactory condition of the radio set. The components are listed in paragraph 3 and illustrated in figure 1 and figures 4 through 14.

(2) Check suitability of the location in which the radio set is to be operated. Check the general installation (par. 29).

(3) Clean dirt and moisture from the antenna, the handset, and all the jacks, plugs, and panels of the radio set components.

(4) Inspect the seating of the fuses and tubes in the radio set components (figs. 42 and 43). Check all plugs and connectors of the system for tightness and proper seating.

(5) Inspect all controls for binding, scraping, excessive looseness, misalinement, and positive action. Figures 33 through 37 show locations of the radio set controls.

(6) Check each component of the system for normal operation. If abnormal results occur at any point in the operating procedure, refer to the equipment performance checklist (par. 69).

(7) Clean and tighten the cables, panel mountings, and connectors of all the radio set components. Refer to figures 26 and 27 for cabling diagrams.

(8) Inspect cases, mountings, the antenna, and exposed metal surfaces for rust, corrosion, and moisture.

(9) Inspect cords, cables, and wires for cuts, breaks, fraying, deterioration, kinks, and strain.

(10) Inspect the antenna for bent mast sections, corrosion, looseness, and damaged insulating material.

(11) Inspect for loose switches, knobs, jacks, transformers, relays, capacitors, and pilot light assemblies.

(12) Clean the meter window of the remote control unit and the pilot light assemblies (figs. 10 and 11).

(13) Check the meter in the remote control unit to see that the pointer is zero set, and not bent.

(14) Inspect the shelter housing of the radio set for adequacy of weatherproofing.

(15) Check the antenna support to see that the antenna installation is not defective.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.
RADIO SET AN/FRC-15	

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).* PAR. 62 a(1)							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 62 a(2)							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 62 a(3)							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 62 a(4)							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 62 a(5)							
6	CHECK FOR NORMAL OPERATION. PAR. 62 a(6)							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 62 a(7)		13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 62 a(8)		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 62 a(12)	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 62 a(9)		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 62 a(13)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS. PAR. 62 a(10)		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING. PAR. 62 a(14)	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION. PAR. 62 a(15)	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 62 a(11)		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-238 REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 282-21

Figure 40. DA Form 11-238.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: RADIO SET AN/FRC-15

EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; ① Defect corrected.
NOTE: Strike out items not applicable.

NO	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).* PAR. 62 a (1)	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 62 a (2)	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 62 a (3)	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 62 a (4)	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 62 a (5)	
6	CHECK FOR NORMAL OPERATION. PAR. 62 a (6)	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 62 a (7)	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 62 a (8)	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 62 a (9)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS. PAR. 62 a (10)	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 62 a (11)	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 62 a (12)	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 62 a (13)	
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING. PAR. 62 a (14)	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION. PAR. 62 a (15)	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	

NO.	ITEM	CONDITION
19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS: INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES. PAR. 62 b (1)	
20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.	
21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 62 b (2)	
22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS. PAR. 62 b (3)	
23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS. PAR. 62 b (4)	
24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 62 b (5)	
25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. PAR. 62 b (6)	
26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 62 b (7)	
27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.	
28	CHECK SETTINGS OF ADJUSTABLE RELAYS.	
29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.	
30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.	
31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 62 b (8)	
32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR. 62 b (9)	
33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.	
34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	
35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.	
37	MOISTURE AND FUNGIPROOF. PAR. 62 b (10)	
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 62 b (11)	

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TM282-23

Figure 41. DA Form 11–239

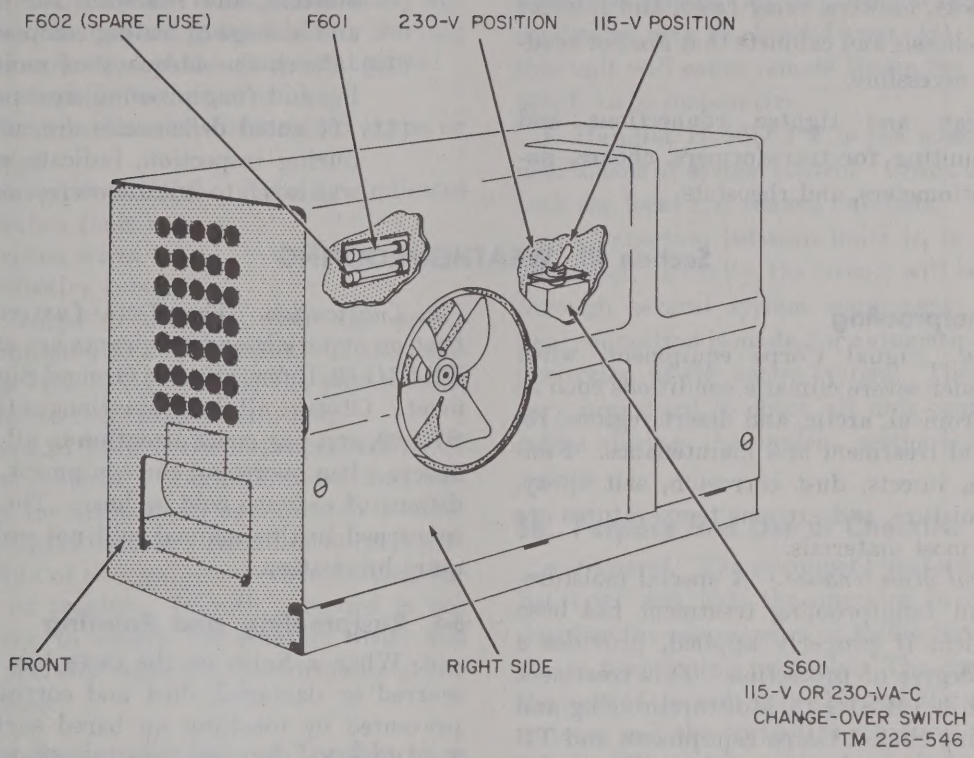


Figure 42. Power Supply PP–804/U, fuse locations.

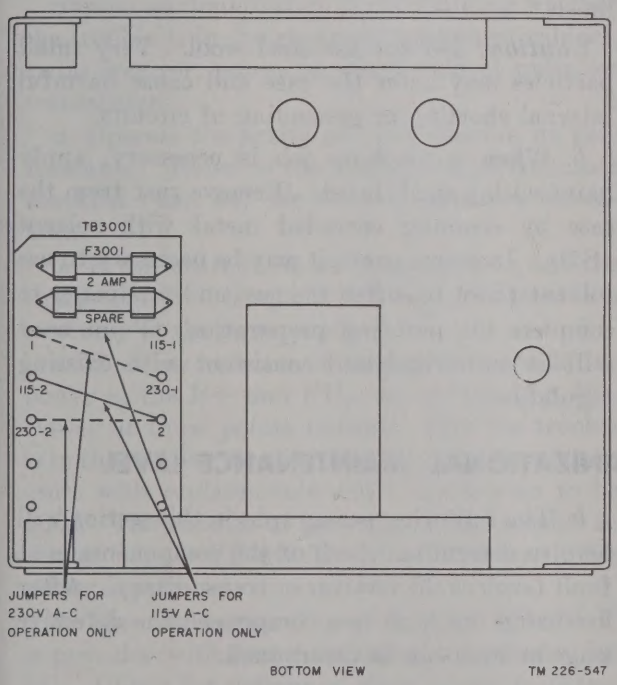


Figure 43. Power Supply PP–846/U, fuse locations.

b. Performing Interior Preventive Maintenance.

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.

(1) Inspect electron tubes (figs. 22, 23, and 24) for loose envelopes, loose cap connectors, cracked sockets, and insufficient socket spring tension; remove dust and dirt carefully.

(2) Inspect fixed capacitors for leaks, bulges, and discolorations.

(3) Inspect relays for loose mountings; burned, pitted, or corroded contacts, misalinement of contacts and springs.

(4) Inspect variable capacitors for dirt, moisture, misalinement of plates, and loose mountings.

(5) Inspect resistors, bushings, and insulators for cracks, chipping, blistering, discoloration, and moisture.

(6) Inspect terminals of large fixed capacitors and resistors for corrosion, dirt, and loose contacts.

(7) Clean and tighten switches, terminal blocks, blowers, relay cases, and interior of chassis and cabinets that are not readily accessible.

(8) Clean and tighten connections and mounting for transformers, chokes, potentiometers, and rheostats.

(9) Inspect transformers, chokes, potentiometers, and rheostats for overheating and leakage of sealing compound.

(10) Check the adequacy of moistureproofing and fungiproofing treatment.

(11) If noted deficiencies are not corrected during inspection, indicate what action was taken to initiate correction.

Section III. WEATHERPROOFING

63. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

c. Arctic Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

e. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69, Lubrication of Ground Signal Equipment. Observe all the precautions outlined in TB SIG 69, and pay strict attention to all lubrication orders when operating the equipment under conditions of extreme cold or heat. The equipment concerned in this manual will not ordinarily require lubrication.

64. Rustproofing and Painting

a. When a finish on the cases has been badly scarred or damaged, dust and corrosion can be prevented by touching up bared surfaces. Use No. OO or No. OOO sandpaper to clean the surface down to the bare metal; obtain a bright, smooth finish.

Caution: Do not use steel wool. Very small particles may enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases, it may be necessary to use solvent (SD) to soften the rust and sandpaper to complete the painting preparation. Paint used will be authorized and consistent with existing regulations.

Section IV. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

65. General

a. The troubleshooting and repair work that can be performed at the organizational maintenance level is limited by the tools, test equipment, and replaceable parts issued, and by the existing tactical situation. Accordingly, troubleshooting is based on the equipment performance and use of the senses in determining such troubles as burned-out tubes, fuses, and defective connectors.

b. The following paragraphs in this section will help to determine which of the components is at fault (such as the receiver or transmitter). After localizing the fault to a component, the defective stage or item can be determined.

66. Visual Inspection

a. Many of the faults that may appear in Radio Set AN/FRC–15 can be detected by visual inspec-

tion of the system components. When failure is encountered and the cause is not immediately apparent, check the following items before starting a detailed examination of the component parts:

(1) Improperly connected cables.
(2) Worn, broken, or disconnected cords or plugs.
(3) Burned-out fuses. (Usually indicates another fault.)
(4) Broken wires.
(5) Defective tubes.

b. Pilot lamps to indicate when the power source is connected to a component. If the indicating lamp fails to light, see if the power cords are connected to their proper terminals.

c. One type of fault is the improper setting of switches and controls. Check the switch and control settings for the mode of operation to be used.

d. It is helpful to have a record of normal performance data of the equipment when looking for the source of trouble. If such a record is not available, try to obtain information from the equipment operator regarding performance at the time of failure.

67. System Sectionalization of Trouble to a Component

System sectionalization is determining whether the trouble is in the electrical equipment cabinet, radio receiver, power supplies, control units, or transmitter.

a. Operate the entire set, and observe its performance. Refer to the equipment performance checklist (par. 69) for normal operation indications.

b. If the entire radio set is inoperative, and the equipment pilot lamps do not light, the trouble is probably in the power source.

c. If either receiver is inoperative, check for power at the B+ and FIL. test points (fig. 38). Power at these points indicates that the trouble is in the receiver circuit. Replace receiver plug-in units with replacements which are known to be good. The absence of power indicates trouble in Power Supply PP–846/U. Check the fuse in the power supply.

d. The transmitter Power Supply PP–804/U is provided with four front panel test points (fig. 37). Check for voltage at these points to determine power supply performance (par. 44).

e. Radio Set Control C–844/U has four front panel test points (fig. 35) from which operating conditions may be checked (par. 42). Failure of this unit will cause remote Radio Set Control C–845/U to be inoperative.

f. Handset H–33D/PT is the most frequently used means of system control. Check operation of both the local and remote handsets.

g. Connection between units is, in most cases, not direct. Usually, the circuit will be completed through several system components before the final connection is made, for automatic control and protection of the entire system. Therefore, it is very important to check all unit connectors and cables during the system sectionalization procedure.

68. Purpose and Use of Checklist

a. General. The equipment performance checklist (par. 69) aids the operator in determining whether the components of Radio Set AN/FRC–15 are functioning properly. The checklist gives the item of the unit to be checked, the normal indications, and the corrective measures that can be taken. When using this chart, follow the items in numerical sequence.

b. Action or Condition. For some items, the information given in the *action or condition* column consists of various switch and control settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indication given in the *normal indication* column.

c. Normal Indication. The normal indications include the visible and audible signs that the operator should perceive when checking the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning in the equipment for repairs. If the set is completely inoperative or if the recommended corrective measures do not yield results, troubleshooting is necessary. However, if the tactical situation requires that communication be maintained, and if the set is not completely inoperative, the operator must keep it in operation as long as possible.

69. Equipment Performance Checklist

	Item No.	Unit	Item	Action or condition	Normal indication	Corrective measures
PREPARATORY	1	Electrical Equipment Cabinet CY–1221(*)/G.	REC 1-SQUELCH OFF switch control.	Set at OFF (extreme clockwise position).		
	2	----------	REC 2-SQUELCH OFF switch control.	Set at OFF (extreme clockwise position).		
	3	----------	CONTROL UNIT-POWER ON-OFF switch.	Not used.		
	4	----------	TRANSMITTER-FREQ. 1-FREQ. 2-switch.	For local operation, set at FREQ. 1 or FREQ. 2 position, depending on desired operating frequency (pars. 31 and 36).		
	5	----------	INTERCOM.-ON-OFF switch.	Spring-loaded; leave at OFF position.		
	6	----------	MAIN POWER-ON-OFF switch.	Set at OFF position.		
	7	Radio Set Control C–845/U.	Frequency selector-intercom switch.	For remote operation, set at FREQ. 1 REC. 1 or FREQ. 2 REC. 1 and 2 position, depending on the desired operating frequency (par. 32).		
	8	----------	MICROPHONE LEVEL control.	Set at a center position.		
	9	----------	SPEAKER VOLUME-OFF switch.	Set at OFF (extreme counterclockwise position).		
	10	----------	SPEAKER ON-OFF switch.	Spring-loaded; leave in ON position (up).		
	11	----------	TONE switch----------	Spring-loaded; leave in up position.		
	12	Radio Transmitter T–417/GR.	TUNE-OPERATE switch--	Set at OPERATE position.		
	13	----------	TEST-OFF switch---------	Set at OFF position.		

START	14	Electrical Equipment Cabinet CY–1221(*)/G.	MAIN POWER-ON-OFF switch.	Set to ON position	MAIN POWER indicator lamp will light.	Check indicator lamp. Check plug at rear of Receiver No. 1 and its mating jack on the inside of Electrical Equipment Cabinet CY–1221(*)/G. Check power cable connections (par. 31).
	15	Radio Set Control C–845/U.	SPEAKER VOLUME-OFF switch.	Set in extreme clockwise position.	POWER lamp will light	Check indicator lamp. Check power input (par. 32).
	16	Electrical Equipment Cabinet CY–1221(*)/G.	REC 1-SQUELCH OFF switch control.	Set at OFF position	Either a signal or a rushing noise will be heard at earpiece of Handset H–33D/PT.	If the volume of the noise is low, or the signal is low or distorted, check the receiver plug-in units by substitution (par. 67).
EQUIPMENT PERFORMANCE	17			Adjust the REC 1-SQUELCH control (par. 47).	No noise present at earpiece of Handset H–33 /PT. Only receiver signals will be heard.	If the squelch control is inoperative, check by substituting another audio and squelch plug-in unit in the receiver.
	18		TRANSMITTER FREQ. 1-FREQ. 2-switch.	For local control, set at FREQ. 1 position. Operate push-to-talk switch of Handset H–33D/PT and talk into microphone.	Contact is established with distant receiver operating on FREQ. 1.	Check antenna connections. Check for proper antenna length (par. 29). Be sure that a jumper is connected across terminals 2 and 3 of TB1902 (par. 31). Check for proper plate coil and antenna filter connections in Radio Transmitter T–417/GR (par. 43).
	19	Radio Set Control C–845/U.	Frequency selector-intercom switch.	For remote control, set at FREQ. 1 REC. 1 position. With remote handset keyed, check polarities on terminals 6 and 7 of TB1902 in Electrical Equipment Cabinet CY–1221(*)/G. Terminal 7 should be positive with respect to terminal 6. If polarities are reversed, reverse the connections of the 600-ohm line at terminals 6 and 7 of TB1902.	Received signals will be heard from loudspeaker and from earphone of Handset H–33D/PT.	Check tubes V2601 and V2602. Be sure that a jumper is connected across terminals 1 and 2 of TB1902 in the equipment cabinet (par. 32).

	Item No.	Unit	Item	Action or condition	Normal indication	Corrective measures
EQUIPMENT PERFORMANCE	20		SPEAKER VOLUME-OFF switch.	Alternately set switch in the four different volume steps.	Signals heard in loudspeaker will increase in audio level with each clockwise step change.	Check switch S2603.
	21		SPEAKER ON-OFF switch.	Hold switch down	Loudspeaker will be muted.	Check switch S2604.
	22		LINE LEVEL meter	Operate push-to-talk switch of Handset H–33D/PT and talk into the microphone.	TRANSMIT lamp lights.	Check lamp; replace if defective.
					LINE LEVEL meter reads −2 db on average voice peaks.	Adjust MICROPHONE LEVEL control (fig. 36).
	23		TONE switch	Hold switch down	A 1,000-cps tone is heard from loudspeaker.	Check tube V2603. Adjust tone level control (fig. 72).
	24		Frequency selector-intercom switch.	Set at INTERCOM position.	Voice communication is established between the local and remote operators, each using a push-to-talk Handset H–33D/PT (par. 50).	Check interconnecting line for a short or open circuit.
	25			Set at FREQ. 2 REC. 1 and 2.	Received signals from both receivers will be heard from the loudspeaker and from the earpiece of Handset H–33D/PT.	Check tubes V2601 and V2602.
STOP	26	Radio Set Control C–845/U.	SPEAKER VOLUME-OFF switch.	Turn to the OFF position	POWER lamp goes out.	
	27	Electrical Equipment Cabinet CY–1221 (*)/G.	MAIN POWER-ON-OFF switch.	Throw to the OFF position	MAIN POWER lamp goes out.	

CHAPTER 5

THEORY

Section I. INTRODUCTION

70. General

A thorough understanding of the functions of Radio Set AN/FRC–15 is important to accomplish efficient operation and maintenance. To develop this understanding, a section has been devoted to each of the following topics.

a. Component Theory. Most of the components in Radio Set AN/FRC–15 have their own manuals; however, a basic block diagram explanation of these components is given in paragraphs 72 through 80. The components which do not have individual manuals are discussed in detail in that section.

b. System Theory. The general functioning of all components, arranged for system operation, is presented in paragraphs 81 through 91. The information in these paragraphs stresses the interdependence of all individual components, and is an effective aid in troubleshooting the equipment to isolate a defective unit.

71. Schematic Diagrams

Many of the functional schematic diagrams in this chapter contain particular stages from two or more individual components. These diagrams are representative of particular features of several components. Identification of particular components is simplified by observing the grouping of part numbers, as explained in the notes on the schematic diagrams and in the text. Although not discussed in detail, a schematic diagram of each component of Radio Set AN/FRC–15 is found in this manual.

Section II. COMPONENT THEORY

72. Block Diagram of Radio Receiver R–257/U

(fig. 44)

a. The signal path through the receiver is shown in block diagram form in figure 44. An fm signal is fed into first rf amplifier V201, where it is amplified. The signal is then fed to second rf amplifier (V202) for further amplification. The selectivity of the two rf amplifiers improves the signal-plus-noise to noise ratio, and the image and if. rejection ratios. The amplified signal is coupled to the first mixer (V203) together with a signal from the LOCAL OSC 25–50 MC plug-in unit (V231, V232, and V233) which is 7.8 mc higher in frequency than the incoming rf signal. Sum and difference frequencies result, but only the difference frequency (7.8 mc) is passed by the following stage, the 7.8-mc if. amplifier (V51). This stage amplifies the 7.8-mc signal, and couples it to the second mixer V52. Here the two frequencies are mixed together to produce sum and difference frequencies, 7.8 mc from the second mixer (V52), and 7.345 mc from the crystal-controlled second hf oscillator (V53). The difference, or beat frequency, is 455 kilocycles (kc). This 455-kc signal is fed through a selectivity filter (Z251), which is tuned to the second if. frequency (455 kc). This signal is amplified by five 455-kc if. amplifier stages (tubes V81 through V85). The output of tube V85 passes through two limiter stages (V86 and V87), which maintain a constant amplitude voltage input to the discriminator, although the received signal may fluctuate because of noise or fading. The discriminator stage changes the f-m signal into an audio signal, which is amplified by the first audio amplifier (V121) and the audio power amplifier (V122) to a level which will operate a loudspeaker or handset.

b. Audio output from the discriminator is also fed to a squelch circuit. The noise amplifier (V123) amplifies receiver noise and couples this

noise signal to the squelch tube (V124). This tube controls the operation of the audio amplifiers (V121 and V122) by biasing their control grids to cutoff, when no signal is being received. A squelch control and squelch disabling switch are provided in Electrical Equipment Cabinet CY–1221(*)/G. The squelch clamp tube (V125) reinforces the action of the squelch tube (V124).

c. Receiver Subassembly MX–1547/G (a relay plug-in unit) contains a relay which is controlled by the audio power amplifier (V122). This relay must be used to control the transmitter in a retransmission installation (par. 33).

d. Strong signals will produce a negative voltage at the grid of the fifth 455-kc if. amplifier (V85). A portion of this negative voltage is used for automatic gain control (agc). The gain of the two rf amplifiers (V201 and V202) is controlled by this agc voltage, which varies directly with the strength of the input signal to the receiver. As the input signal strength increases, this agc voltage increases and lowers the gain of the two rf amplifiers.

73. Block Diagram of Radio Transmitter T–417/GR

(fig. 45)

Radio Transmitter T–417/GR is an fm transmitter covering the frequency range of 25 to 50 mc. Two oscillator circuits are incorporated in the transmitter to provide a choice of either one of two preset frequencies. The nominal power output of the transmitter is 45 watts. In Radio Set AN/FRC–15, the transmitter output is fed directly to the transmitting antenna. Radio Transmitter T–417/GR consists of the following stages:

a. First Audio Amplifier. Audio signals from the microphone of Handset H–33D/PT, or signals from a radio receiver (retransmission) are applied through an impedance-matching transformer and a pre-emphasis network to the control grid of the first audio amplifier tube (V311). The output of this stage is coupled to the grid of the limiter tube V312.

b. Limiter. The limiter tube (V312) clips the peaks of the audio signal. The output of this tube is passed through a de-emphasis network and applied to the second audio amplifier.

c. Second Audio Amplifier. The audio level of the amplified output of this amplifier tube (V313) is adjusted by a deviation control and applied to the grid of the phase modulator tube (V303).

d. Rf Oscillator. Two crystal-controlled oscillator stages (V301 and V302) allow a quick change between the two predetermined operating frequencies. The oscillator to be used is selected by a switch on Radio Set Control C–845/U or Electrical Equipment Cabinet CY–1221(*)/G depending on which unit has control. This switch allows filament voltage to be applied to one of the oscillator stages. A frequency of 1.5625 to 3.125 mc. depending on the crystal used, is fed to the plate and control grid of tube V303.

e. Phase Modulator. The application of rf oscillator voltage to both the control grid and plate of the phase modulator tube (V303) and the application of audio voltage only to the control grid, provides the proper relationships for phase modulation.

f. Buffer. The buffer stage (V304), which is a subminiature tube (5678), furnishes a constant load for the modulator, and is an isolating stage. Its rf output is at the same frequency as the oscillator, with a deviation of 937.5 cycles.

g. First Doubler. The first doubler (V305) has a single-tuned plate circuit that operates at twice the crystal frequency, with a deviation of 1,875 cycles. This output is applied to the grid of the second doubler tube (V306).

h. Second Doubler. The second doubler (V306) has a single-tuned plate circuit that operates at four times the crystal frequency, with a deviation of 3,750 cycles. This output is applied to the grid of the third doubler tube V307.

i. Third Doubler. The third doubler (V307) has a tuned plate and grid circuit. The plate circuit operates at eight times the crystal frequency, with a deviation of 7,500 cycles. This output is applied to the grid of the driver/doubler tube (V308).

j. Driver/Doubler. The driver/doubler stage (V308) is a type 2E26 tube, and has its plate circuit tuned to 16 times the crystal frequency, with a deviation of 15 kc. This stage is inductively coupled to the grid circuit of the power amplifier tubes (V309 and V310).

k. Power Amplifier. The power amplifier consists of two type 6146 tubes, V309 and V310, operated in parallel. The pi-type plate tank is tuned to resonance by a variable capacitor. A coarse adjustment of antenna coupling is made by fixed capacitors, and a fine adjustment, by a variable

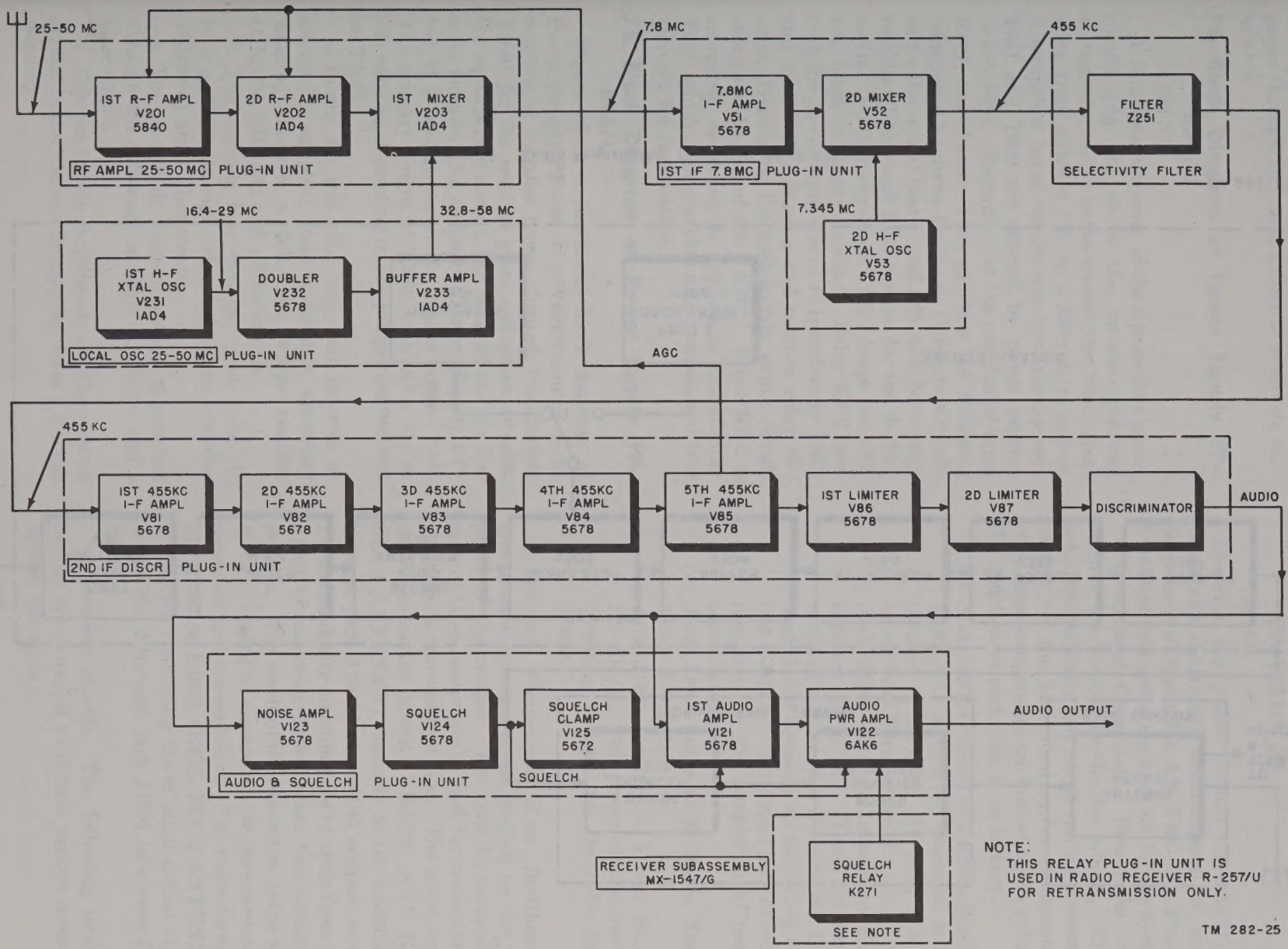


Figure 44. Radio Receiver R-257/U, block diagram.

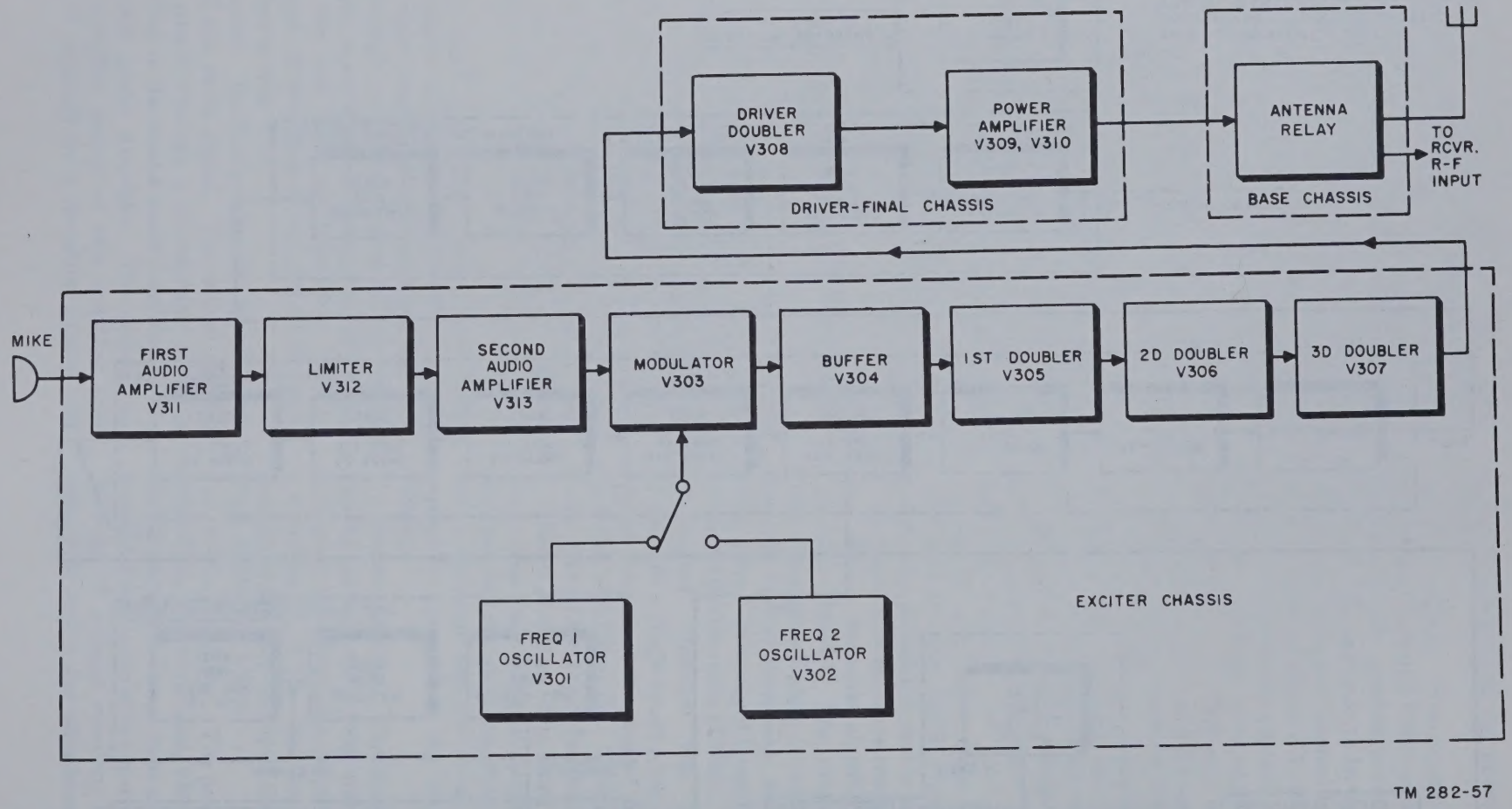


Figure 45. Radio Transmitter T-417/GR, block diagram.

capacitor. Power output from the final amplifier passes through an antenna filter to attenuate harmonics.

74. Block Diagram of Power Supply PP–804/U

(fig. 46)

A functional diagram of the transmitter power supply (fig. 46) shows the various operating voltages furnished to the transmitter when operating from either a 115- or a 230-volt ac source. Appropriate input connections for transformers T601 and T602 are selected by power selector switch S601. Regardless of the position of relay K601, transformer T602 provides the following voltages: 6.3 volts ac for the ac filaments, 6.3 volts ac for the crystal heater, and 1.35 volts dc through rectifier CR606 and filter circuit for the dc filaments. Voltage regulator CR607 keeps the 1.35-volt filament supply constant. Relay K601 controls the power input circuit to transformer T601, and the receiver muting and antenna relay circuits. Grounding the push-to-talk switch circuit energizes the coil of relay K601. When K601 is energized, ac power is applied to transformer T601, which then provides plate, screen, and bias voltages for rectification.

75. Block Diagram of Power Supply PP–846/U

Figure 47 is a functional block diagram of Power Supply PP–846/U. When mounted in the receiver, it supplies power through transformer T3001 for the receiver plate and screen circuits, the squelch bias circuit, and both ac and dc filament circuits. An additional Power Supply PP–846/U is used to power the remote control unit. The primary circuit of T3001 uses either 115 or 230 volts ac, depending on the jumper connections on T3001.

a. Power for the 160-, 155-, and 145-volt dc circuits is supplied from a common secondary winding through a full-wave bridge rectifier (CR3003, CR3004) and a filter circuit.

b. The squelch bias voltage, −40 volts dc, is supplied through the half-wave rectifier (CR3005) and a filter circuit.

c. The 1.4-volt dc filament voltage is supplied through the full-wage rectifier (CR3001) and a filter circuit.

d. Current for the ac filaments and the receiver crystal heater element is supplied from a 6.3-volt winding.

76. Theory of Electrical Equipment Cabinet CY–1221(*)/G

(fig. 82)

Electrical Equipment Cabinet CY–1221(*)/G houses and electrically interconnects the major components of Radio Set AN/FRC–15. Thus, it is a centralized operating position for the system.

a. Component Connectors. Five jacks (connectors) are located inside the cabinet. These jacks automatically connect to similar connectors (plugs) on the individual system components, when these components are housed in the cabinet. The function of each jack is as follows:

(1) Jack J1901 connects to a Radio Receiver R–257/U. A receiver connected at this position is optional. If used, it is referred to as Receiver No. 2.

(2) Jack J1902 connects to another Radio Receiver R–257/U. This receiver is supplied and is called Receiver No. 1.

(3) Jack J1903 connects to Radio Set Control C–844/U. This local control unit is necessary for the completion of remote control circuits.

(4) Jack J1904 connects to Radio Transmitter T–417/GR.

(5) Jack J1905 connects to Power Supply PP–804/U. This power supply provides operating voltages for the radio transmitter.

b. Antenna Connectors. Two feedthrough-type coaxial connectors are located on the rear panel of the cabinet. The outside terminal of each of these connectors is used for connection to an antenna transmission line. The inner terminal of connector E1902 (TRANS. AND REC. NO. 1 ANTENNA) connects to the transmitter through jack J1904. A coaxial adapter is used for mechanically matching the rf cable from jack J1904 to connector E1902, when this connection is made. The result of the connection is the automatic changing of circuits to use one antenna for reception and transmission. The inner terminal of connector E1901 (REC. NO. 2 ANTENNA) is used for connecting the rf input circuit of Receiver No. 2 through jack J1901 to a second antenna.

c. Terminal Boards. The following terminal boards are provided to permit various modes of system operation:

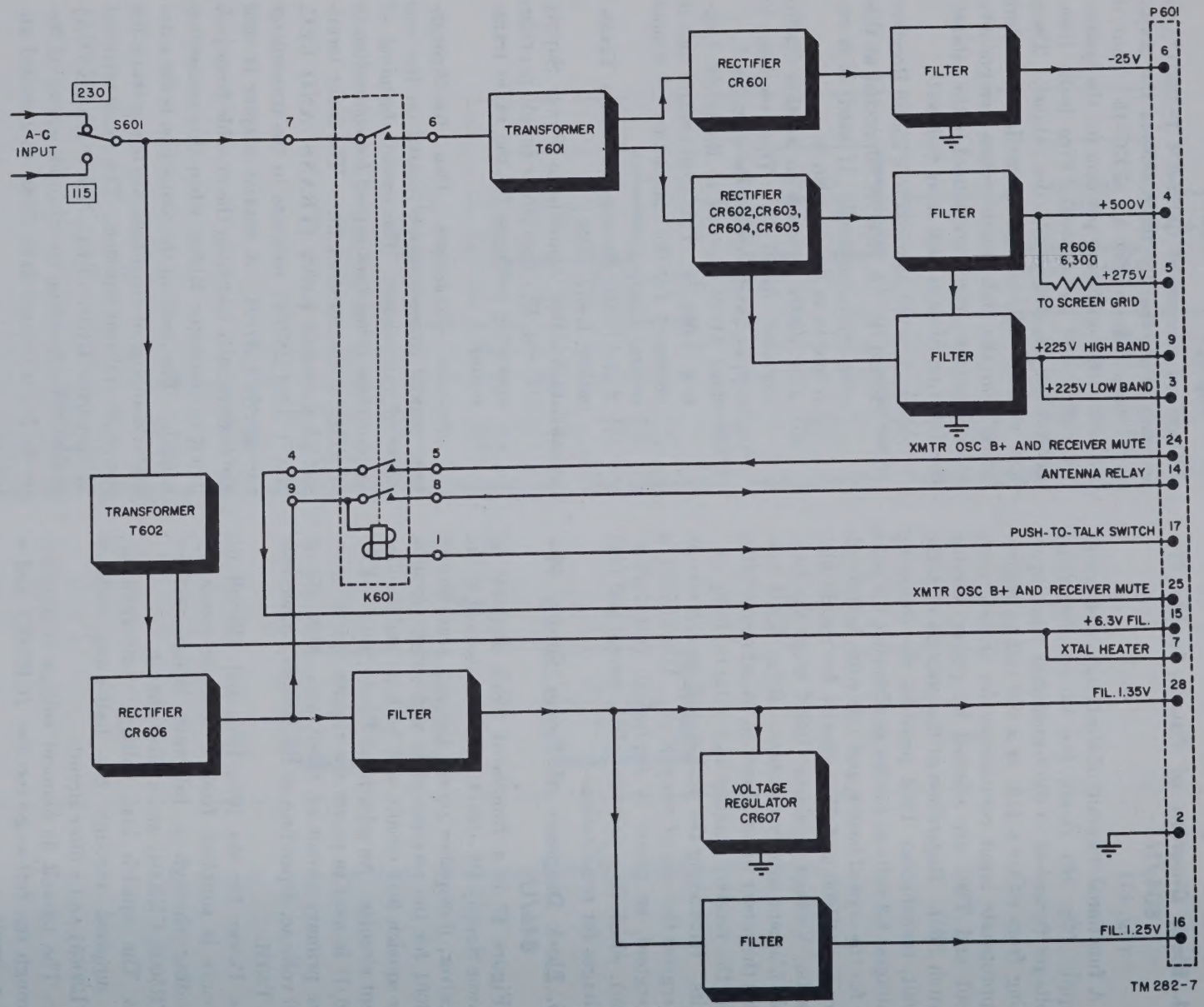


Figure 46. Power Supply PP-804/U, block diagram.

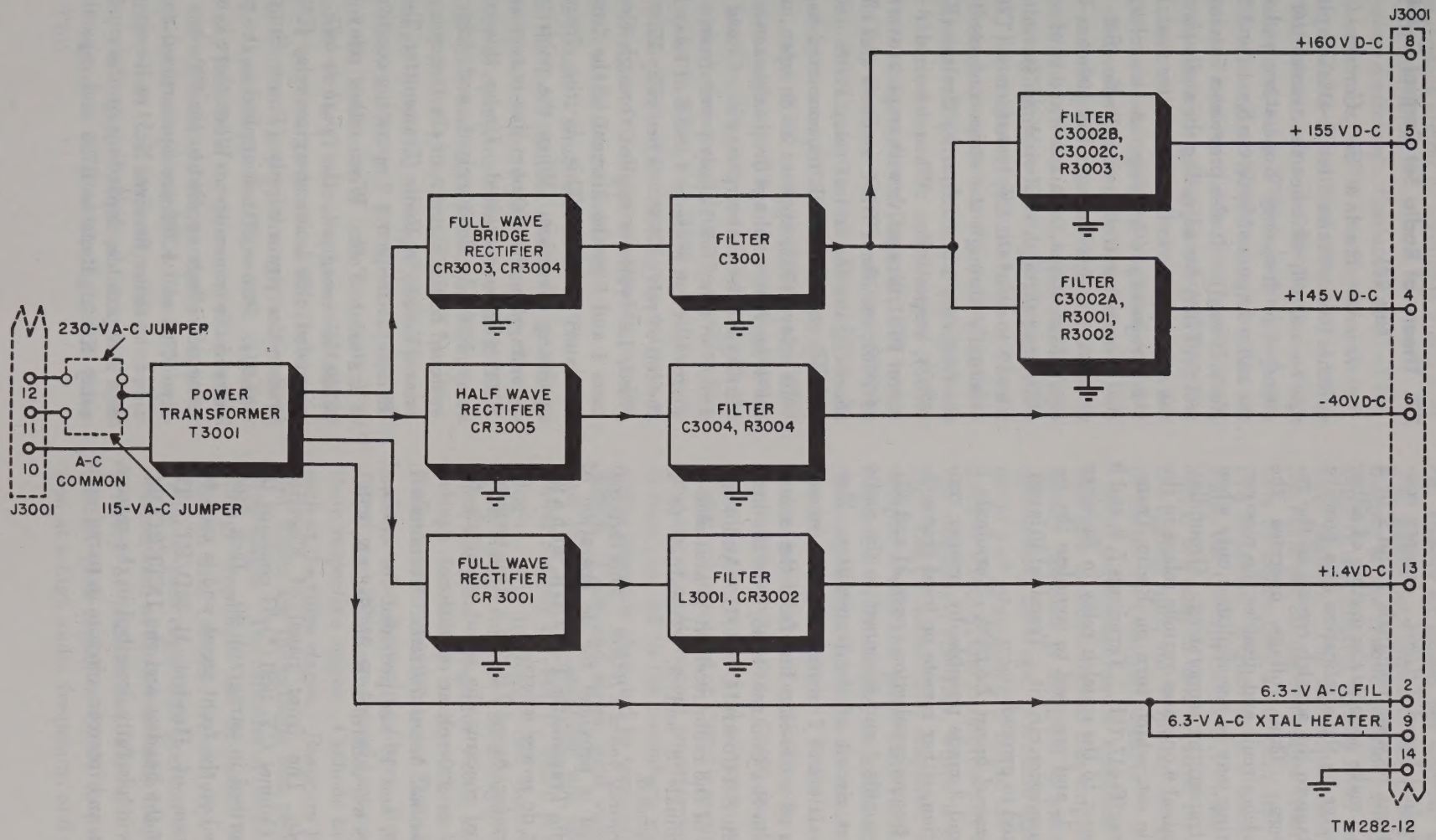


Figure 47. Power Supply PP–846/U, block diagram.

(1) *Terminal board TB1901.* Jumper connections between terminals 1 and 2 or 2 and 3 make possible the muting of either receiver by the application of a positive voltage to the squelch circuit in the receivers. This voltage operates the squelch circuit and disables the receiver. Muting may be accomplished only when the transmitter is operating. Grounding terminal 6 operates various relays in the radio set, which turn on Radio Transmitter T–417/GR. Terminals 7, 8, and 9 connect to the squelch relay in Receiver No. 1, and are used to complete the retransmission circuit. Terminal 10 is connected to ground.

(2) *Terminal board TB1902.* Terminals 1, 2, and 3 made possible, by jumper connection, either remote or local transmitter frequency selection (pars. 31 and 32). Terminals 4 and 5 connect to the audio input circuit of the transmitter. Terminals 6 and 7 provide for the connection of a 600-ohm line from the remote Radio Set Control C–845/U to the local Radio Set Control C–844/U. Audio output of the radio receivers is available at terminals 8 and 9. Terminal 10 is grounded.

(3) *Terminal board TB1903.* This terminal board is provided for dc operation of Radio Transmitter T–417/GR, with a 24-volt dc power source.

(4) *Terminal board TB1904.* This terminal board contains the input terminals for 115- or 230-volt ac operation.

(5) *Terminal board TB1905.* Terminals 1, 2, 9, and 10 are provided for optional ac power control in Radio Set AN/FRC–15.

d. Controls. The front panel of Electrical Equipment Cabinet CY–1221(*)/G contains the controls described in paragraph 40. Jack J1907 is also located on the front panel, and is used for the connection of Handset H–33D/PT. The operation of the handset and the INTERCOM.-ON-OFF switch is fully described in the receive, push-to-talk, and intercom circuits in paragraphs 81 to 91.

77. Theory of Radio Set Control C–844/U (fig. 78)

a. General. Radio Set Control C–844/U switches Radio Transmitter T–417/GR plate voltage on and off, switches the transmitter to frequency 1 or frequency 2 operation, and switches the audio outputs of Receiver No. 1 (and Receiver No. 2, if used). It also provides a line input control (AT701) for adjusting the audio signal from the remote point to the transmitter modulator.

b. Frequency Changing. A dc voltage from the remote control unit (Radio Set Control C–845/U) is fed through the 600-ohm line, the equipment cabinet, terminals 8 and 10 of connector P701, and through two windings (terminals 1 to 2 and 3 to 4) of the line transformer (T701), and eventually through the series-connected coils of the frequency 1 and frequency 2 relays (K701 and K702), respectively. When terminal 8 of connector P701, is negative with respect to terminal 10 of P701, rectifier CR701 conducts and effectively short-circuits the coil of relay K702. Since the polarity of rectifier CR702, connected in parallel with relay K701, appears as an open circuit to the dc current, a voltage drop exists across the coil of relay K701, thus energizing it. Closed contacts 4 and 5 of relay K701 apply power from a 160-volt source through contacts 3 and 5 of relay K702, to the coil of relay K703. When relay K703 is energized, 1.25 volts is applied through closed contacts 4 and 5 to the filament of the frequency 1 oscillator (V301). This is the frequency 1 operating condition. When the polarity of the dc voltage on the 600-ohm line is reversed, relay K702 will be energized. Under this condition, relay K703 is de-energized, and 1.25 volts is switched to the filament of the frequency 2 oscillator (V302), in Radio Transmitter T–417/GR. This is the frequency 2 operating condition.

c. Push-to-Talk. When either relay K701 or K702 is energized, the *push-to-talk* line is grounded; this action energizes relay K601 in the transmitter power supply (Power Supply PP–804/U). Power is then applied to the plate circuits in the transmitter. When there is no polarizing dc voltage applied to the 600-ohm line, relays K701 and K702 are de-energized and reception from either Receiver No. 1 or Receivers Nos. 1 and 2 is possible, depending on the condition of relay K703. Resistor R705 and capacitor C702

minimize contact arcing at terminals 1 and 2 of relays K701 and K702.

d. Receiver Switching. Contacts 2 and 1 of frequency selector relay K703 are connected in parallel with contacts 4 and 5 of frequency 1 relay K701. For transmission on frequency 1, relay K701 is energized, relay K702 is de-energized, and relay K703 is energized (*b* above). When the remote operator releases the handset push-to-talk switch, the polarizing voltage is removed from the 600-ohm line and relay K701 is de-energized. Relay K703 remains energized by its closed contacts 1 and 2, which allow current to flow from the 160-volt source through the three dropping resistors, through contacts 3 and 5 of relay K702, and through the coil of relay K703. With relay K703 energized, the output of Receiver No. 2 is connected through contacts 6 and 7 to load resistor R704. Resistor R704 replaces the speaker as a load for the receiver. The audio output of Receiver No. 2 is disconnected from the line transformer. Only Receiver No. 1 is connected to the line transformer through terminal 28 of P701. In the frequency 2 transmit condition, relay K702 is energized, relay K701 is de-energized, and relay K703 is de-energized. When the remote operator releases the handset push-to-talk switch, the polarizing voltage is removed from the 600-ohm line, and relays K701, K702, and K703 are all de-energized. With K703 de-energized, the outputs of Receivers No. 1 and No. 2 are connected in parallel, and applied to the line transformer.

e. Microphone Voltage and Filter. The microphone in the local handset receives a dc voltage from the Receiver No. 1 power supply, through terminal 29 of connector P701, when the INTER-COM.-ON-OFF switch, in Electrical Equipment Cabinet CY–1221(*)/G, is in the ON position. This voltage is reduced through two series-connected resistors R709 and R710, which are connected in the local control unit at terminal 30 of connector P701. The microphone of Handset H–33D/PT connects to terminal 27 of connector P701, and returns to ground through resistor R711 and filter capacitor C703. This filter capacitor removes any hum from the dc source which would impair the operation of the handset. Capacitor C701 appears as an open circuit to the dc polarizing voltage, used for frequency control, but it effectively ties together terminals 2 and 3 when an audio signal is coupled through line transformer T701.

78. Theory of Radio Set Control C–845/U

a. Radio Set Control C–845/U is a control unit located at the remote position, which is used to amplify and control signals from and to the remote position. The transmitter and receivers in the radio set can be controlled from this control unit by connecting a 600-ohm line between the two locations. Figure 48 is a block diagram of Radio Set Control C–845/U. Power Supply PP–846/U is a plug-in unit required for operation of the control unit, and is not an individual section of Radio Set Control C–845/U.

b. A three-stage audio amplifier (fig. 49) is used as a microphone and line amplifier. Its frequency response is designed to attenuate at approximately 3,500 cps. An audio signal from terminal 4 of relay K2602 is fed to the control grid, pin 2 of V2601A, and is amplified by the first voltage amplifier (V2601A), which is one-half of a type 12AU7 tube. The amplified signal is developed across the plate load resistor (R2628). Capacitor C2605 couples the audio signal through isolating resistor R2626 to the control grid of the second voltage amplifier (V2601B). This signal is then amplified and applied across plate load resistor R2629. Capacitor C2606 couples this audio signal to the control grid of power amplifier tube V2602. The output of V2602 is applied across the primary of audio output transformer T2602, and is then coupled to the secondary winding. The audio power is then fed to terminal 14 of relay K2602. Plate and screen grid voltages for the two tubes in the amplifier are obtained from Power Supply PP–846/U, which is mounted as a plug-in unit in Radio Set Control C–845/U. Plate voltage for tube V2602 is approximately 160 volts, and plate voltage for V2601, and screen grid voltage for V2602 is approximately 155 volts. Resistor R2630 and capacitor C2604B function as a plate circuit decoupling filter. Resistors R2617, R2627, and R2631 are the grid return resistors for their respective stages. Cathode bias is used in each of the three stages. Resistors R2618, R2619, and R2632 are the cathode bias resistors for the three stages. The cathodes of the first and second voltage amplifiers are by-passed by capacitors C2604A and C2602A, respectively. These large value by-pass capacitors prevent cathode degeneration, even at the lower audio frequencies. The primary of transformer T2602 is by-passed to ground with capacitor C2607 to prevent oscillation at a high audio frequency, and also to lower

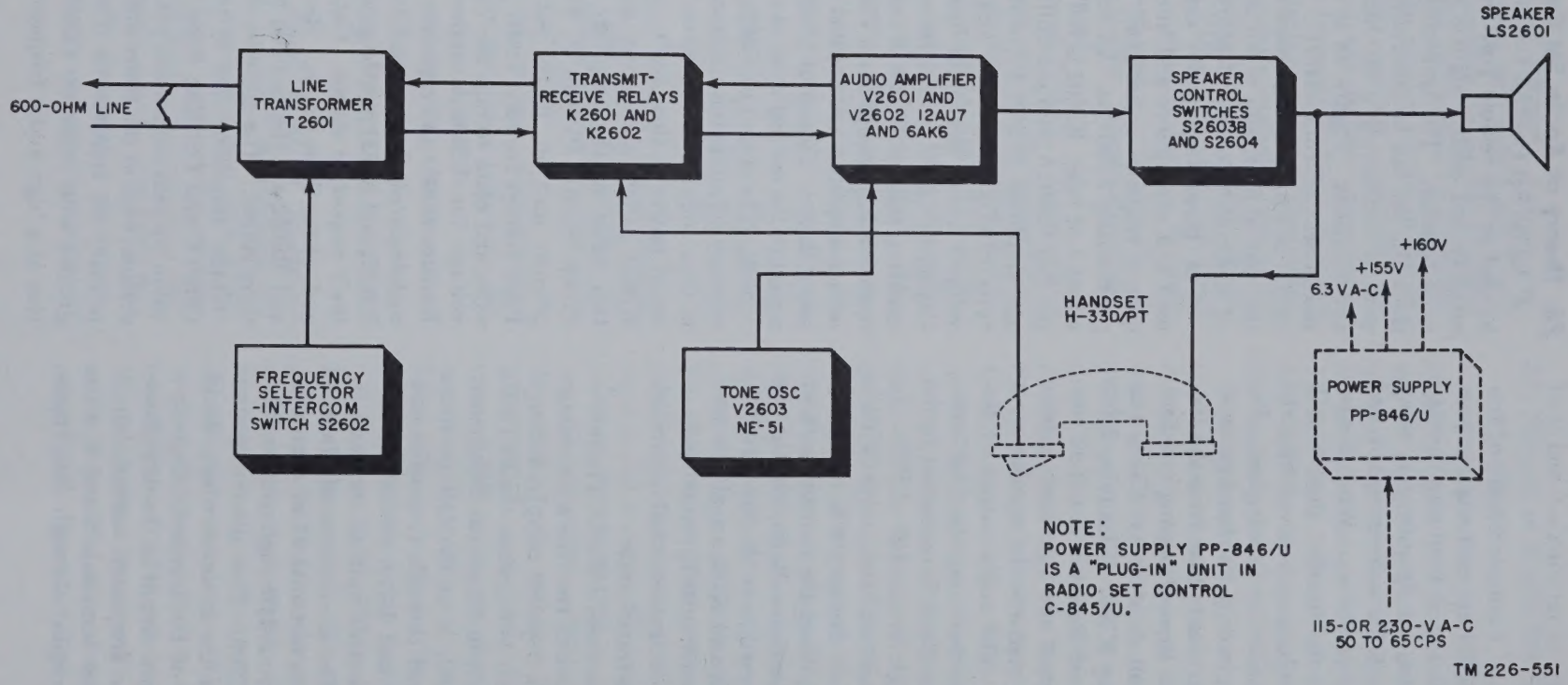
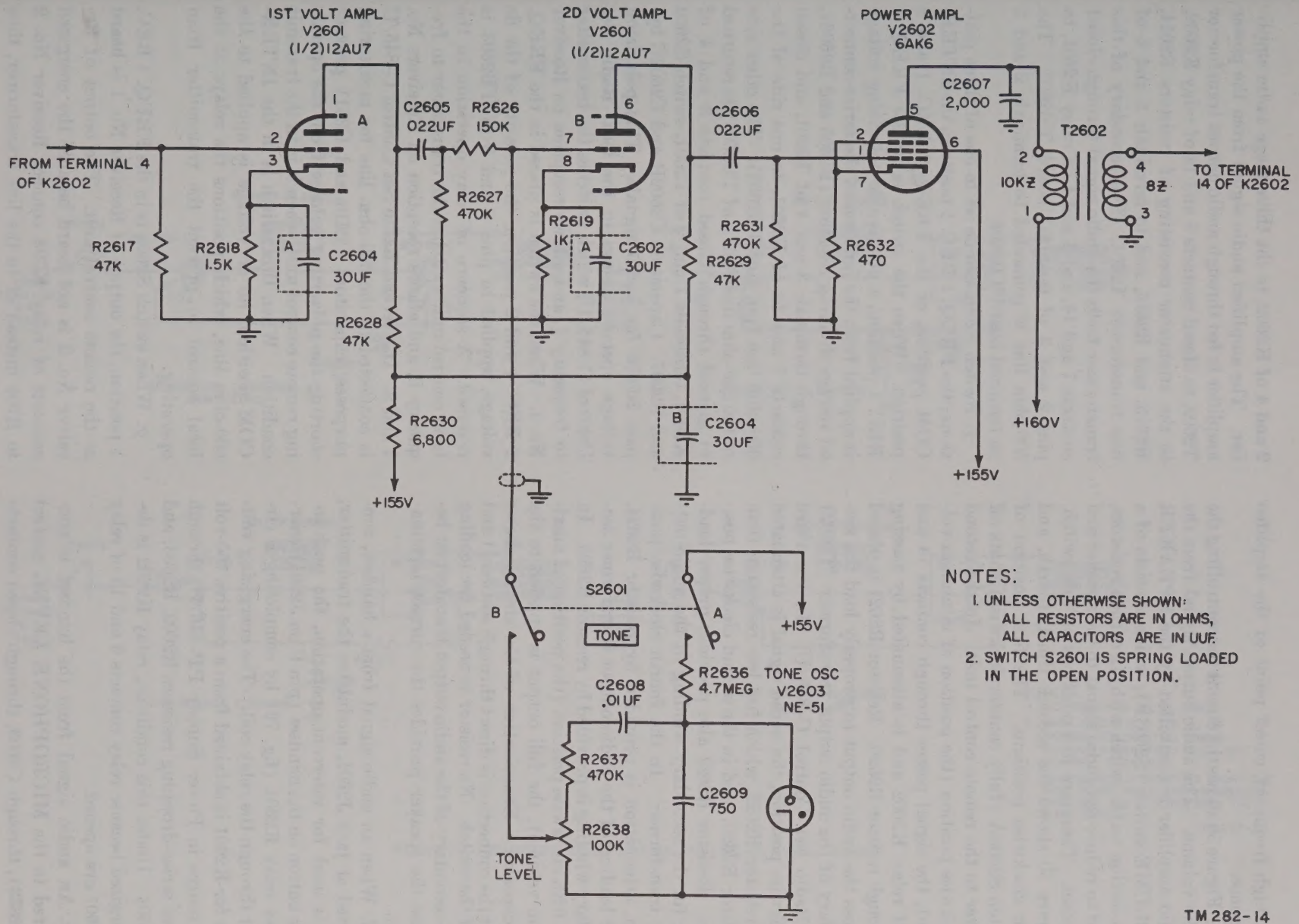


Figure 48. Radio Set Control C-845/U, block diagram.



NOTES:

1. UNLESS OTHERWISE SHOWN:
   ALL RESISTORS ARE IN OHMS,
   ALL CAPACITORS ARE IN UUF.
2. SWITCH S2601 IS SPRING LOADED
   IN THE OPEN POSITION.

TM 282-14

Figure 49. Audio amplifier and tone oscillator circuits.

the high-frequency cutoff point of the amplifier response.

c. Figure 50 shows the circuit for controlling the audio volume. The audio output signal from the audio amplifier is controlled by the SPEAKER VOLUME switch (S2603B), which consists of a two-section wafer switch with six carbon resistors, used to reduce the audio signal to the speaker and handset. There are five positions on this switch. Figure 50 shows the second, third, fourth, and fifth clockwise positions. The first position of switch S2603A (fully counterclockwise) shuts off power to the remote control unit. In the second clockwise position (the position of minimum volume), the signal passes through contacts 14 and 7 of relay K2602 and is attenuated by passing through resistor R2620. Resistor R2621 is placed across the audio output to properly load the secondary of the audio output transformer (T2602) in Radio Set Control C–845/U. In the third clockwise position, the audio signal is attenuated by resistor R2622, which has less resistance than resistor R2620, used in the second clockwise position. Resistor R2623 also provides proper loading for the secondary winding of the audio output transformer. In the fourth clockwise position, attenuation is provided by resistor R2624, and loading of the audio output transformer secondary winding is provided by resistor R2625. In the fifth clockwise position (the position of maximum volume), the full output is applied to the loudspeaker. Examination of the circuit shows that the connection is direct through sections 1 and 2 of the switch. No resistor is needed for loading the secondary of the audio output transformer because the speaker provides the correct termination.

d. When an audio signal from a handset, connected at jack J2601, modulates the transmitter, or is used for intercom operation, the push-to-talk button on the handset (pin F on J2601) energizes relay K2601 (fig. 79) by completing a circuit through the relay coil. The energizing voltage for K2601 is obtained from a positive 160-volt dc source in Power Supply PP–846/U, through three series-dropping resistors R2602, R2603, and R2604. Under this condition, relay K2602 is deenergized because relay contacts 6 and 13 of relay K2601 are opened.

e. An audio signal from the handset is connected to the MICROPHONE LEVEL control (R2633), through C2603, through closed contacts 2 and 4 of K2602, to the three-stage audio amplifier. The amplified audio signal from the power amplifier is fed through audio output transformer T2602, to closed contacts 8 and 14 of relay K2602, to the attenuator consisting of resistors R2614, R2615, and R2616, and to terminals 5 and 6 of line transformer T2601. The secondary of this transformer feeds the audio signal through closed contacts 7 and 14, and 3 and 4 on relay K2601, to pins 2 and 3 of terminal board TB2603. The 600-ohm line is connected to terminals 2 and 3 on terminal board TB2603.

f. Switch S2602 can be set to one of three positions; the FREQ. 1 REC. 1 position, the INTERCOM position, or the FREQ. 2 REC. 1 and 2 position. When the switch is in the FREQ. 1 REC. 1 position, a positive dc polarizing voltage is applied from the junction of the series-connected voltage dividing resistors (R2605 and R2606), through terminals 3 and 4 of T2601, and closed contacts 7 and 14 of K2601, to one side of the 600-ohm line (pin 2 of TB2603). The other side of the 600-ohm line (pin 3 of TB2603) is returned to ground through closed contacts 3 and 4 of K2601, terminals 1 and 2 of T2601, switch S2602 and R2607. Capacitors C2602B and C2602C bypass R2606 for audio signals. This polarizing voltage operates relays in the local Radio Set Control C–844/U, which switches the transmitter to frequency 1, and allows reception on Receiver No. 1. When the switch is placed in the FREQ. 2 REC. 1 and 2 position, the polarity of the dc voltage, applied to pins 2 and 3 of TB2603 is reversed. A sequence of relay operation in the local control unit switches the transmitter to frequency 2, and allows reception on Receivers No. 1 and 2. If a second Radio Set Control C–845/U is connected to the 600-ohm line for monitoring purposes, capacitors C2610 and C2611 prevent shorting the polarizing voltage from the operating remote control unit, when it is in the transmit condition. When this switch is in the INTERCOM position, no dc voltage is applied to the 600-ohm line, which positions the relays at the local control to prevent the transmitter from operating.

g. When switch S2602 is in the FREQ. 1 REC. 1 position, the output of Receiver No. 1 is heard at the remote control unit. The output of Receiver No. 2 is not heard because the energized contacts of relay K703 connect Receiver No. 2 to R704 instead of to the line transformer, thus

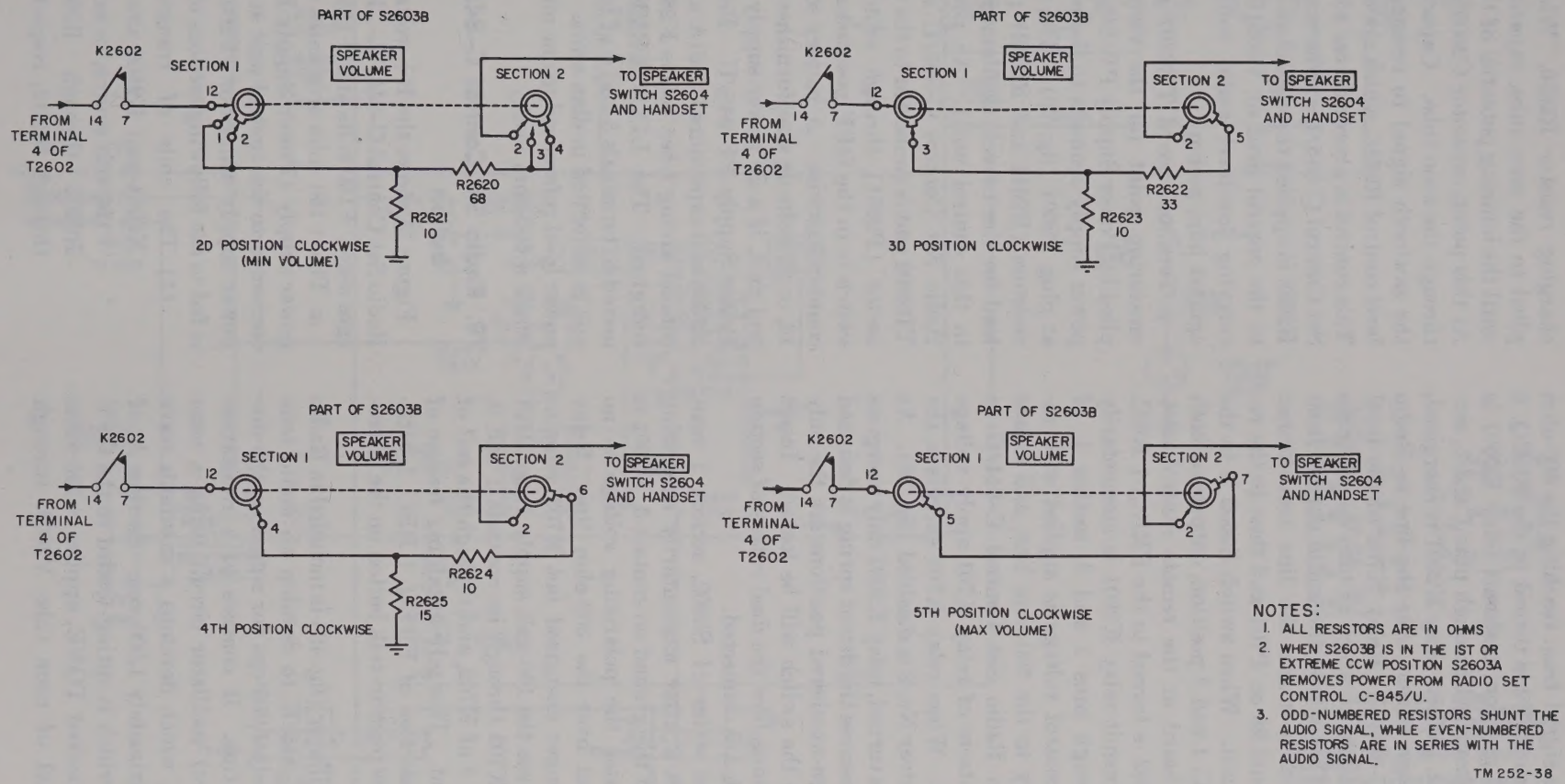


Figure 50. Radio Set Control C–845/U, volume control circuit.

preventing the signal from reaching the 600-ohm line. As switch S2602 is turned to the FREQ. 2 REC. 1 and 2 position, transmit relay K2601 is momentarily energized through pins 1 and 5, section 1 of S2602. When relay K2601 is energized, a control voltage is sent over the line to Radio Set Control C–844/U. Relay K702 in the local control unit energizes, which in turn de-energizes relay K703. This allows the audio output from Receiver No. 2 to reach the line transformer through terminal 28 on P701 and then to the remote control unit. When switch S2602 is in the FREQ. 2 REC. 1 and 2 position, outputs of both receivers are heard at the remote control unit. As switch S2602 is turned to the FREQ. 1 REC. 1 position, transmit relay K2601 is momentarily energized through pins 1 and 3, section 1, of S2602. The control voltage is applied with reversed polarity to the 600-ohm line, and causes relay K701 in Radio Set Control C–844/U to energize. Contacts of relay K701 apply voltage to relay K703. When relay K703 energizes, the output of Receiver No. 2 is disabled (fig. 78). As switch S2602 is turned, relay K2601 only energizes momentarily because the detent spring is designed so that the even-numbered positions are the only ones on which the switch will be locked. Insert A, figure 79 shows how the dual rotors of section 2 of the switch are connected.

h. When the wafer of S2602, section 1 rear, reaches contact 2 after momentarily energizing K2601 through the ground on contact 3, K2601 is de-energized and the polarizing voltage is no longer sent out over the 600-ohm line. Relay K701 is no longer energized but K703 remains energized because the 160-volt supply from R701 is applied to K703 through its contacts 1 and 2, contacts 3 and 5 of K702, and through the coil of K703 to ground. This self-sustaining feature of K703 allows selection of FREQ. 1 REC. 1 without pressing the push-to-talk button on the microphone.

i. A tone oscillator (fig. 49) is included in Radio Set Control C–845/U to develop an audio tone of approximately 1,000 cps for signaling the distant radio station. It consists of a resistance-capacitance (rc) oscillator circuit using a neon bulb (V2603), which develops a sawtooth wave form of approximately 1,000 cps. Section A, of switch S2601, which is spring-loaded to the OFF position and marked TONE, applies +155 volts to one terminal of neon tube V2603, through charging resistor R2636. When voltage is applied to the neon tube, capacitor C2609 charges until the ionizing potential of the neon is reached. At this point, capacitor C2609 rapidly discharges through the neon tube. Capacitor C2608 couples the sawtooth signal to resistor R2637 and tone level control R2638, which are connected in series. This control is a screwdriver adjustment in Radio Set Control C–845/U. The sawtooth signal from R2638 is applied through closed contacts S2601B, to the control grid of V2601B. All wire leads carrying low-level audio voltages are shielded against hum pickup.

j. Terminal board TB2601 may be used as a measuring point for the various voltages supplied by Power Supply PP–846/U (par. 8). This power supply connects to the remote control unit at plug P2601 (fig. 79). The parallel-connected resistors (R2641 and R2642) provide a constant load for the 1.4-volt dc filament source (not used in this control unit). Ac power is applied to Radio Set Control C–845/U at terminal board TB2602 and is connected to the power supply connector (P2601) through switch S2603A. This switch is in the OFF position when turned fully counterclockwise. A battery source supplying 6, 12, or 24 volts dc also furnishes power to the control unit, if a dc power supply is substituted for Power Supply PP–846/U. Resistors R2601 and R2608 and capacitors C2601A and C2601B reduce contact arcing when relays K2601 and K2602 are energized. The LINE LEVEL meter is connected to terminals 5 and 6 of transformer T2601, and is calibrated in dbm units. (Dbm refers to a power level referenced to one milliwatt, developed across a 600-ohm load.)

79. Radio Set Control C–845/U, B+ Distribution

Figure 51 shows the B+ voltage distribution in Radio Set Control C–845/U. There are two voltages used; +160 volts and +155 volts.

a. The +160 volts originates at the control unit power supply (Power Supply PP–846/U) and is connected to the control unit at terminal 8 of the power supply connector (P2601). This voltage is fed to the following sections of the control unit:

(1) The coils of transmit-receive relays K2061 and K2602 are connected to the +160-volt source, in series with resistors R2602 through R2604, and R2610 through R2612, respectively. These re-

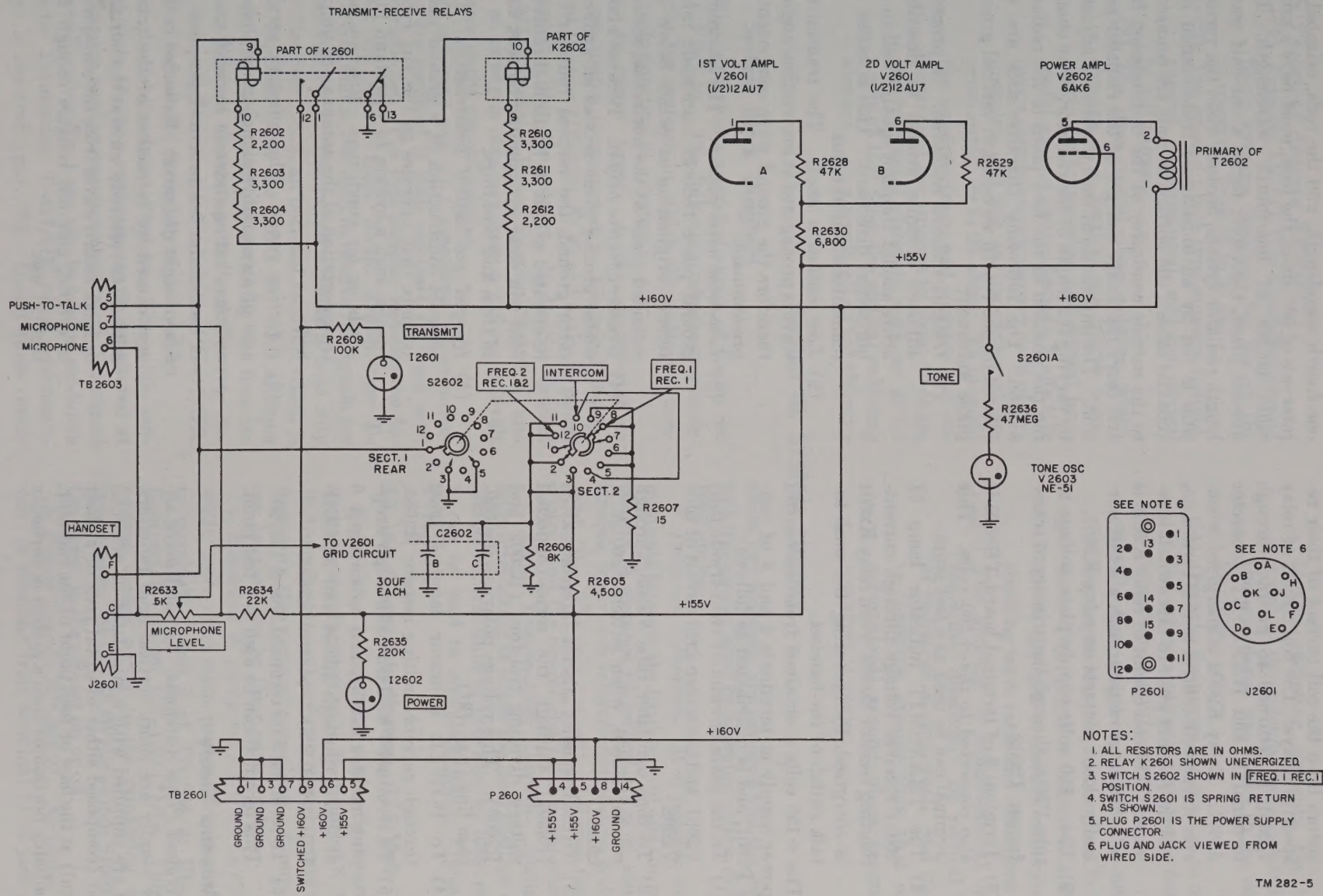


Figure 51. Radio Set Control C-845/U, B+ distribution schematic diagram.

sistors limit the coil current of their respective relays. The coil circuit of relay K2601 is returned to ground through terminal F and HANDSET connector J2601. Relay K2602 is energized whenever the remote control unit is turned on, and the handset push-to-talk switch is released. The coil circuit of relay K2602 is returned to ground through a set of normally closed contacts on relay K2601.

(2) The +160 volts supply plate voltage to tube V2602, through the primary of transformer T2602.

(3) Terminal 6 of terminal board TB2602 is also connected to the +160 volts. This terminal can be used as a test point.

(4) The TRANSMIT indicator lamp (I 2601) receives voltage through current-limiting resistor R2609, when relay K2601 is energized, by operating the push-to-talk switch of the handset.

b. The +155 volts is obtained from the control unit power supply at terminals 4 and 5 of connector P2601, and is distributed as follows:

(1) To the plate circuits of twin-triode tube V2601, and the screen grid circuit of tube V2602.

(2) To tone oscillator tube V2603, through resistor R2636, when switch S2601A is closed.

(3) To the frequency selector-intercom switch (S2602) through the series-connected voltage dividing resistors (R2605 and R2606). This voltage polarizes the 600-ohm line (par. 78*f*).

(4) To POWER indicator lamp I 2602 through current-limiting resistor R2635.

(5) To terminal 7 of TB2603 through dropping resistor R2634, and to terminal 6 of J2601, through R2634 and MICROPHONE LEVEL control R2633.

(6) To terminal 5 on terminal board TB2601. This terminal can be used as a test point.

80. Antenna Theory

a. Ground Plane Antennas. Ground plane antennas usually are short vertical stub radiators, which are supplied with a simulated or artificial ground (composed either of metal rods or a sheet of metal) at the base or feed point of the radiator. The radiator portion of such a system is normally one-fourth wavelength, and the rods, oriented at intervals of 90° about the base, must have a minimum length of one-fourth wavelength. The ground plane, therefore, forms a one-half wavelength radiator system, because when the vertical stub is fed by an unbalanced transmission line (coaxial cable), the horizontal rods are connected to the outside conductor of the transmission line and carry the image charges of the radiator portion. The impedance of such a system is adjusted by varying the length of the radiator, or by changing the position of the feed point to the radiator section. The following characteristics are exhibited by one-fourth wavelength vertical ground plane antennas:

(1) *Omnidirectional radiation.* A properly adjusted antenna system as described above should transmit equally well in all horizontal directions. This is called an omnidirectional antenna.

(2) *Low radiation angle.* The transmitted wave is propagated at low vertical angles; therefore the ground wave component is predominant.

(3) *Low-local noise pickup.* The horizontal ground plane reduces man-made interference originating at points below the extended plane of the horizontal section.

(4) *Greater effective height.* Because a horizontal ground plane acts as an artificial earth ground, the vertical radiator can be elevated so that its horizontal radiated field will clear surrounding objects, such as trees and buildings.

(5) *Rugged mechanical construction.* The compact construction of a ground plane antenna that operates in the vhf range enables such a system to withstand high winds or icy conditions. Erection and transportation of the antenna are simplified.

(6) *Effective range.* The effective service area of an omnidirectional ground plane antenna that operates in the vhf range is limited for all practical purposes to line-of-sight distances. Extended coverage, caused by refraction of the transmitted (or received) wave at the horizon, or freak return waves from the ionosphere is erratic, and not reliable enough for tactical use.

b. Theory of Antenna AS–612/U.

(1) Antenna AS–612/U is a modified ground plane antenna designed for use in the rf spectrum from 25 to 50 mc.

(2) The ground plane type antenna is light, rugged, nondirectional, and not critical in adjustment.

(3) The true ground plane antenna, which consists of a vertical one-fourth wavelength radiating whip and several horizontal ground plane elements, is effective over a comparatively narrow band of frequencies, and has an impedance of approximately 20 to 25 ohms. To broaden the band coverage and increase the impedance of the antenna to about 50 ohms, the horizontal elements were set at an angle of 142° from the vertical radiating element. As a result, all of the elements became radiating elements, the bandwidth of the antenna was increased, and the impedance was raised to the desired 50 ohms.

(4) Over the frequency range of 25 to 50 mc, the antenna radiating elements must be varied in length (par. 29).

(5) The best length for Cord CG–399A/U was experimentally determined to be 68 feet. This length is critical and should not be changed because it minimizes the standing wave ratio and reflections.

(6) The antenna is nondirectional in the horizontal direction. Its vertical angle of radiation is very small, and its gain is therefore greater than that of the conventional ground plane antenna at low vertical angles.

Section III. SYSTEM THEORY

81. System Block Diagram

Figure 52 shows a block diagram of Radio Set AN/FRC–15. The following subparagraphs describe the manner in which the radio set components function as a system.

a. Ac Power Input. A 115- or 230-volt ac power source is connected to Electrical Equipment Cabinet CY–1221(*)/G and to the ac power supplies within the cabinet. Radio Set Control C–845/U contains Power Supply PP–846/U, and its ac power is obtained from a 115- or 230-volt source at the remote location.

b. Antenna and Rf Connections. Two antennas are required if both receivers are used with the radio set. The first antenna radiates the 45-watt fm signal from Radio Transmitter T–417/GR, and is also used to receive fm signals for Receiver No. 1. The second antenna is used only for Receiver No. 2, an optional receiver, which is not supplied with the radio set. An antenna switching relay, used for switching the first antenna between the transmitter and Receiver No. 1, is located in Radio Transmitter T–417/GR. All rf signals are carried by coaxial cables.

c. Audio Receiving Circuits. The audio output from the two receivers can be monitored at either the local or remote control unit. The signal from Receiver No. 1 can also be used to modulate Radio Transmitter T–417/GR when retransmission is required (par. 33). Under these conditions, two antennas are required and the receiver and transmitter must be operated on two different frequencies.

d. Intercom Operation. It is possible to communicate between the local control and the remote control, a distance of several miles in some instances, when such intercommunication is desired (par. 50). The only connection between the local control and the remote control is a 600-ohm line.

e. Audio Transmitting Circuits. Audio signals, originating at either the local position or the remote control unit, or provided by Receiver No. 1, can be used to modulate Radio Transmitter T–417/GR.

82. Ac Power Distribution, 115-Volt

Figure 53 is a simplified schematic diagram of the ac power distribution in Radio Set AN/FRC–15, from the 115-volt ac input to each power transformer in the various components. Components can be identified by their part number.

a. Electrical Equipment Cabinet CY–1221(*)/G. The input power cable is connected to terminals 1 and 2 of TB1904 in Electrical Equipment Cabinet CY–1221(*)/G. This connection brings power to the remaining system components. MAIN POWER switch S1903 turns the power in the cabinet on or off.

b. Power Supply PP–804/U. Ac power (115-volt) is obtained from terminal 11 of jack J1905

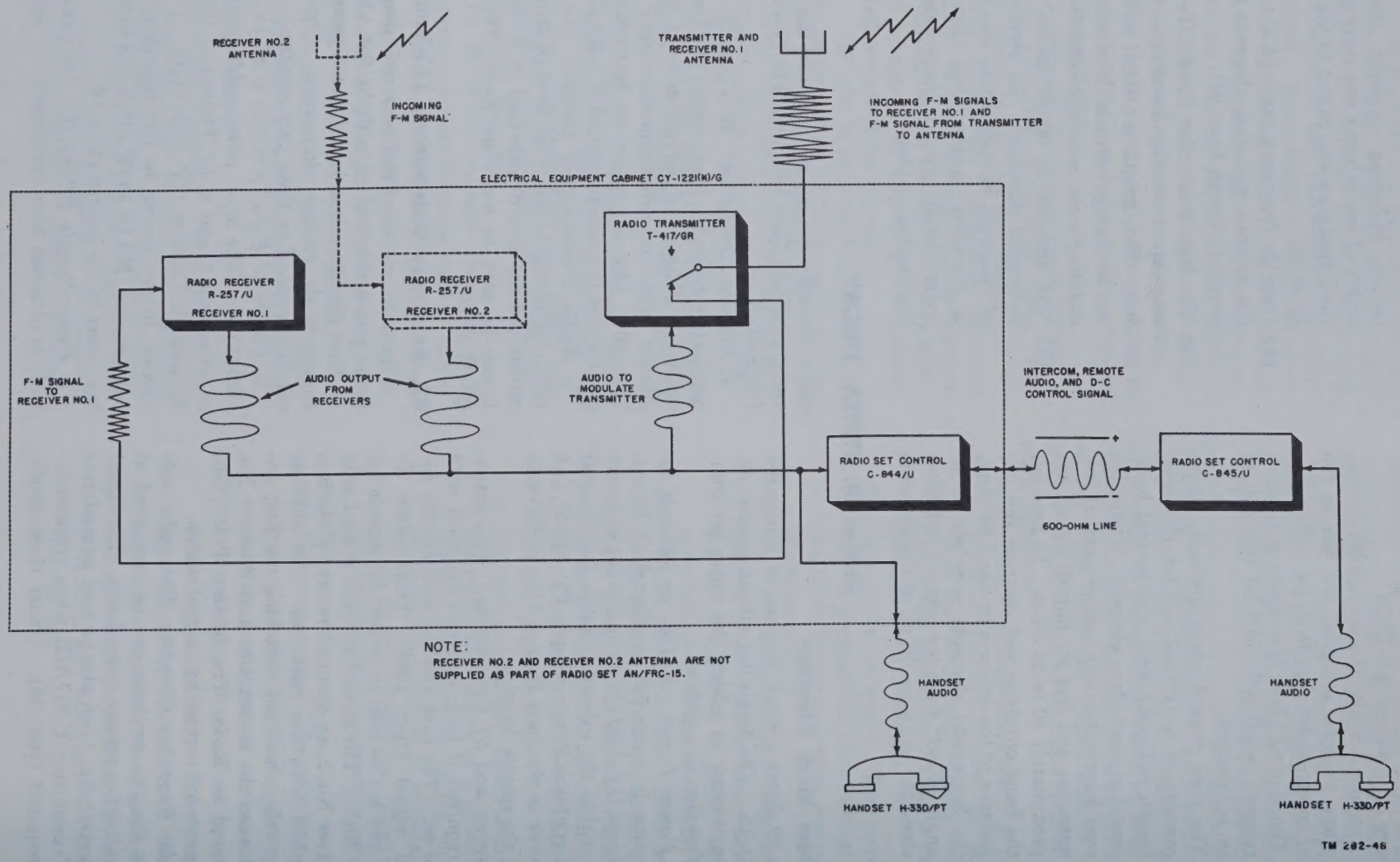


Figure 52. Radio Set AN/FRC–15, functional block diagram.

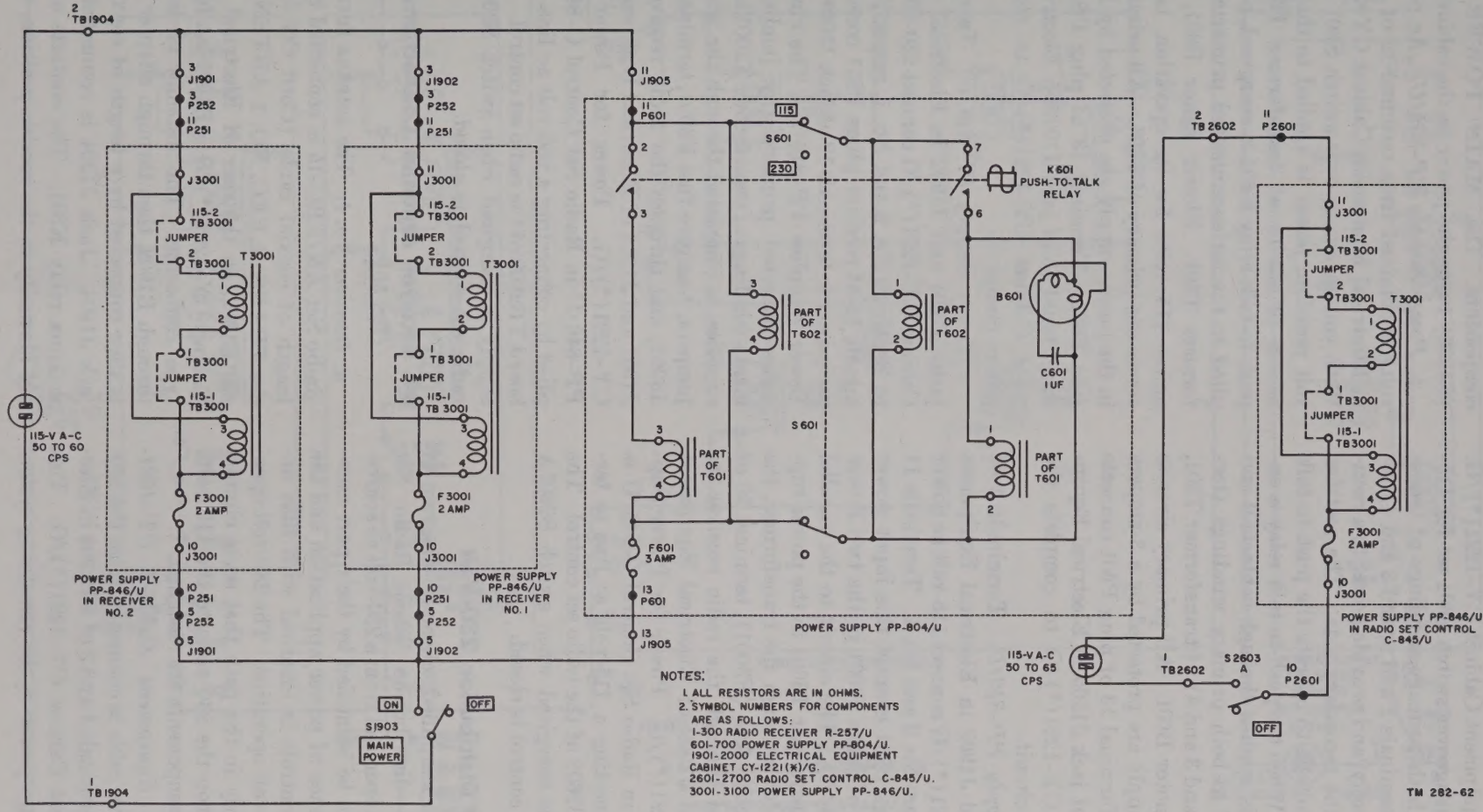


Figure 53. Input power distribution circuit (115-volt ac).

in Electrical Equipment Cabinet CY–1221(*)/G. With voltage changeover switch S601 set for 115-volt operation, both primary windings of transformer T602 (terminals 1 and 2, and 3 and 4) receive power directly, and provide power to a rectifier circuit on the secondary side. The rectifier produces a dc voltage to operate the push-to-talk relay (K601). When the push-to-talk relay is energized, power is applied through contacts 2 and 3, and 6 and 7 to both primary windings (terminals 1 and 2, and 3 and 4) of transformer T601, and to blower motor B601. All primary circuits in the power supply are protected by a 3-ampere fuse (F601). Terminal 13 of plug P601 connects to terminal 13 of jack J1905 in Electrical Equipment Cabinet CY–1221(*)/G to complete the primary power circuit.

c. Power Supply PP–846/U. Terminals 3 of jacks J1901 and J1902 in Electrical Equipment Cabinet CY–1221(*)/G connect 115-volt ac power to radio Receivers No. 2 and No. 1. Terminals 11 of receiver plugs P251 connect this input power to terminals 11 of jacks J3001 in the two Power Supplies PP–846/U. The circuit to the parallel windings of transformer T3001 in the power supplies, is completed through the transformer, the 2-ampere protective fuse (F3001), terminal 10 of jack J3001, and through the radio receiver, to jacks J1901 and J1902 of Electrical Equipment Cabinet CY–1221(*)/G. Power for Power Supply PP–846/U in Radio Set Control C–845/U is applied by connecting a 115-volt ac line to terminal board TB2602 of the radio set control. The power supply is energized when switch S2603A in the radio set control is closed.

83. Ac Power Distribution 230-Volt

Figure 54 is a simplified schematic diagram of the ac power distribution when Radio Set AN/FRC–15 is operated from a 230-volt ac source. Components can be identified by their part number. The sequence of power application and the action of all controls is identical with that described for 115-volt operation. The 230-volt operation differs only in the path that some circuits must take to drop the 230 volts to the 115 volts for which the components are designed.

a. Electrical Equipment Cabinet CY–1221-(*)/G. A power cable is connected from the 230-volt source to terminals 1 and 3 of TB1904 in Electrical Equipment Cabinet CY–1221(*)/G. This connection brings power to the remaining system components. The MAIN POWER switch (S1903) turns the power in the cabinet on or off.

b. Power Supply PP–804/U. Ac power (230-volt) is obtained from terminal 12 of jack J1905 in Electrical Equipment Cabinet CY–1221(*)/G. With voltage changeover switch S601 in the 230-volt position, power is applied to the series-connected primaries of transformer T602. When push-to-talk relay K601 is energized, power is applied to the series-connected primaries of transformers T601. Blower motor B601, which requires 115 volts for its operation, is connected across one primary of T601. All primary circuits in the power supply are protected by 1½-ampere fuse F601. Terminal 13 of plug P601 connects to terminal 13 of jack J1905 in Electrical Equipment Cabinet CY–1221(*)/G to complete the power circuit.

c. Power Supply PP–846/U. Terminals 4 of jacks J1901 and J1902 in Electrical Equipment Cabinet CY–1221(*)/G connect 230-volt ac power to Receivers No. 2 and No. 1, respectively. Terminals 12 of receiver plugs P251 connect this input power to terminals 12 of jack J3001, in the two Power Supplies PP–846/U. The circuit to the series-connected primary (by jumper arrangement) windings of transformer T3001 in the power supplies, is completed through the windings, the jumpers, 2-ampere fuse F3001, terminal 10 of jack J3001, and through the radio receiver to jacks J1901 and J1902 of Electrical Equipment Cabinet CY–1221(*)/G. Power for Power Supply PP–846/U in Radio Set Control C–845/U is applied by connecting a 230-volt ac line to terminal board TB2602 of the radio set control. The power supply is energized when switch S2603A in the radio set control is closed.

84. Receiver Antenna Connections

(fig. 55)

a. Receiver No. 1. The antenna furnished with Radio Set AN/FRC–15 is connected by a 68-foot length of coaxial cable (Cord CG–339A/U) to the TRANS. & REC. NO. 1 ANTENNA, terminal E1902, on the rear of Electrical Equipment Cabinet CY–1221(*)/G. E1902 is a feedthrough-type connector. The antenna rf input passes through E1902, then through adapter E1903, and is then connected by a length of coaxial cable to jack J1904. Jack J1904 is connected to coaxial antenna relay K301. The contacts of the relay are normally in the receive position, which com-

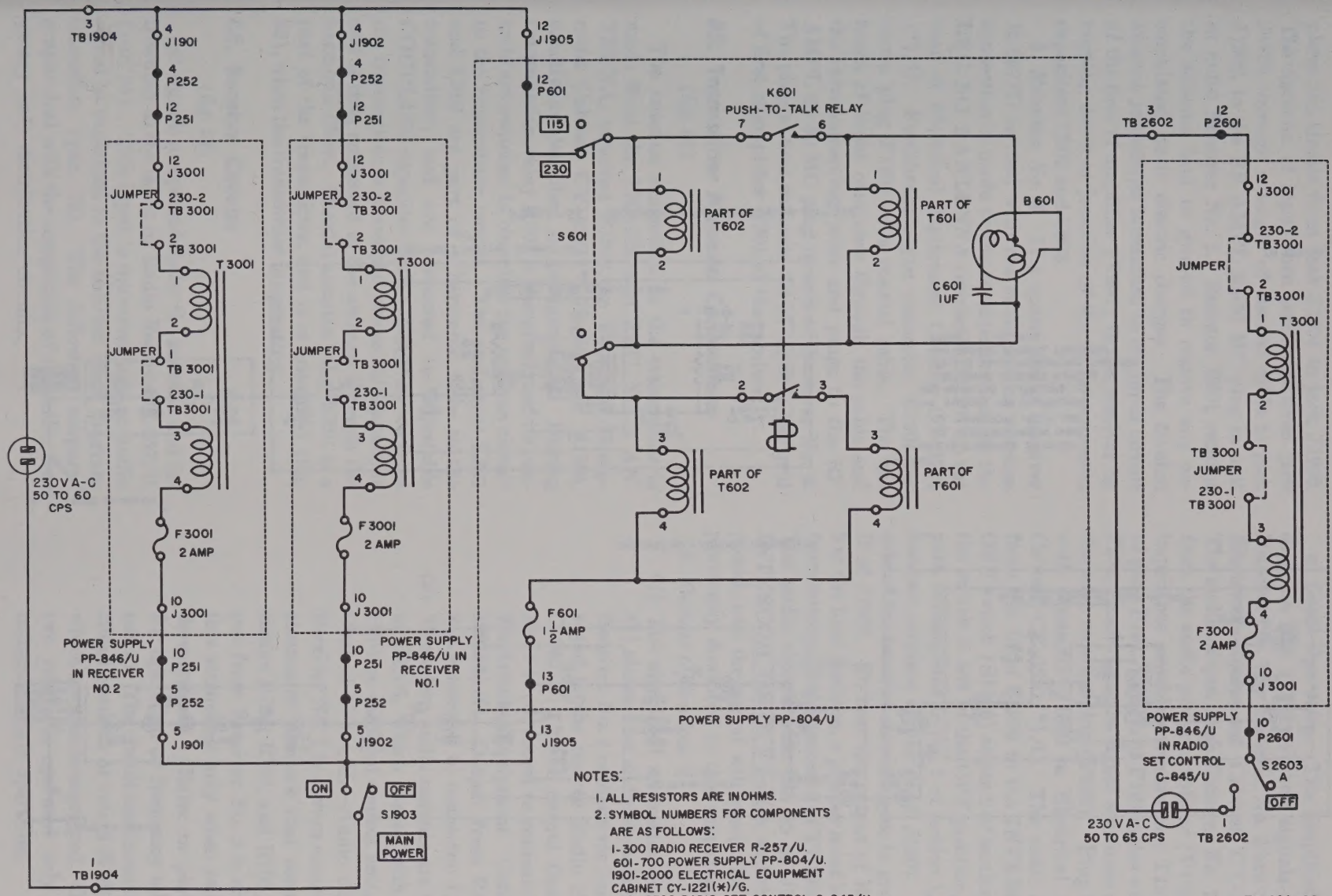
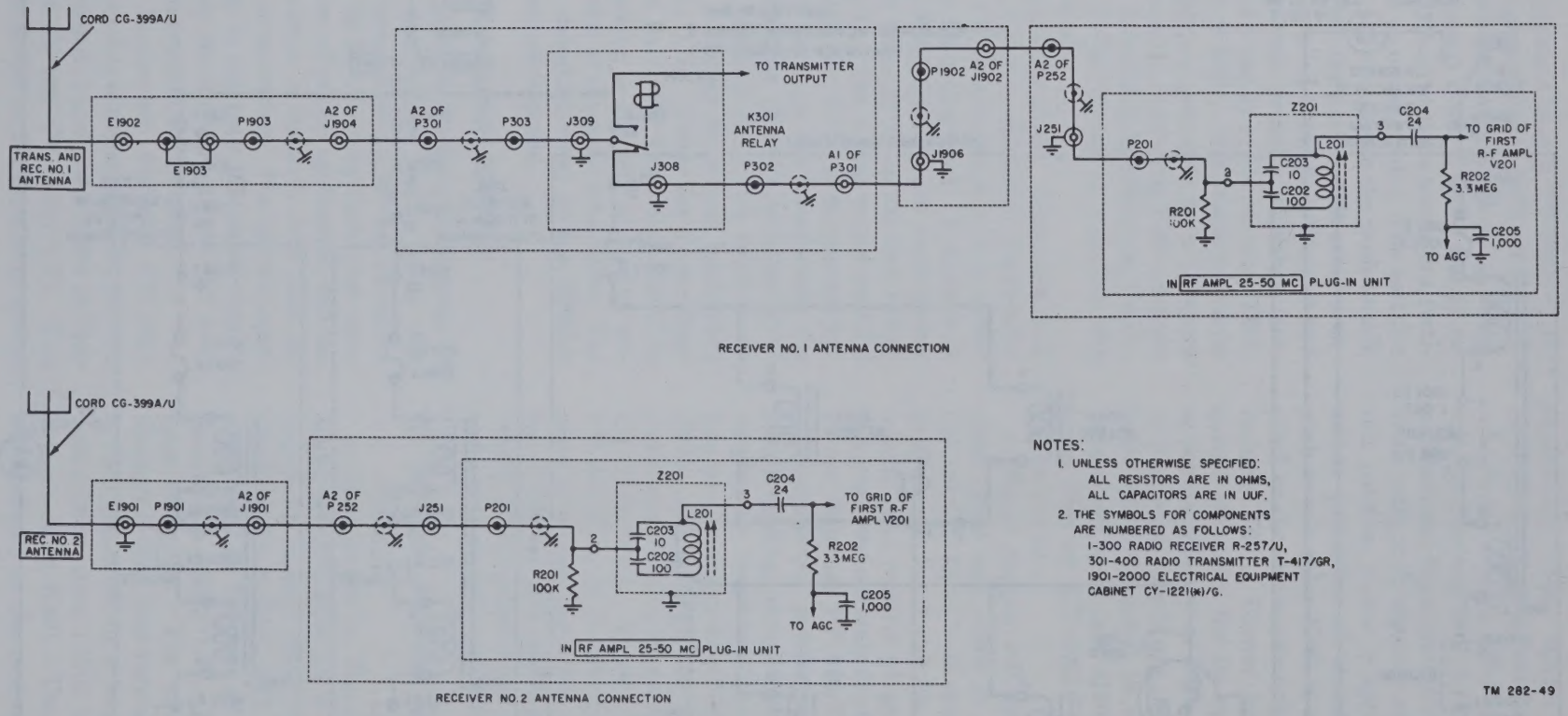


Figure 54. Input power distribution circuit (230-volt ac).



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS,
   ALL CAPACITORS ARE IN UUF.
2. THE SYMBOLS FOR COMPONENTS ARE NUMBERED AS FOLLOWS:
   1-300 RADIO RECEIVER R-257/U,
   301-400 RADIO TRANSMITTER T-417/GR,
   1901-2000 ELECTRICAL EQUIPMENT CABINET CY-1221(*)/G.

TM 282-49

Figure 55. Receiver rf distribution circuit.

pletes the circuit from jack J1904 to jack J1906. The antenna rf input then continues from jack J1906 through a length of coaxial cable to jack J1902, to the RF AMPL 25–50 MC plug-in unit in radio Receiver No. 1. Resistor R201 returns the antenna lead to ground to remove any accumulated static electric charges. The 50-ohm antenna impedance is matched to the input circuit of the first rf amplifier (V201) in the receiver by tapping down at junction of the series-connected capacitors C202 and C203.

b. Receiver No. 2. If a spare Radio Receiver R–257/U is used with the radio set, its antenna connection is made to the outside terminal of the REC. NO. 2 ANTENNA connector, E1901 on the rear of Electrical Equipment Cabinet CY–1221 (*)/G. Feedthrough-type connector E1901 receives plug P1901 of a coaxial cable. The antenna rf input continues through the cable and the interconnecting jacks and plugs to the RF AMPL 25–50 MC plug-in unit of Receiver No. 2. The plug-in unit connects the rf input to the grid of first rf amplifier V201 of the receiver.

85. Transmitter Antenna Connections
(fig. 56)

The antenna connection to the transmitter is made from the TRANS. and REC. NO. 1 ANTENNA, terminal E1902, on Electrical Equipment Cabinet CY–1221(*)/G, to jack J1904, exactly as described in paragraph 84. During transmission, relay K301 is energized, and its contacts are switched to complete the antenna circuit to the transmitter output. Two inductors L321 and L322 are part of a harmonic filter in the transmitter, and are connected to adjustable COUPLING capacitor C355. The rf signal from the transmitter is developed across this capacitor and is then connected to the antenna through the harmonic filter. Coaxial antenna relay K301 is a part of the transmitter, and it is energized (fig. 55), when the transmitter is operating.

86. Receive Circuits
(fig. 57)

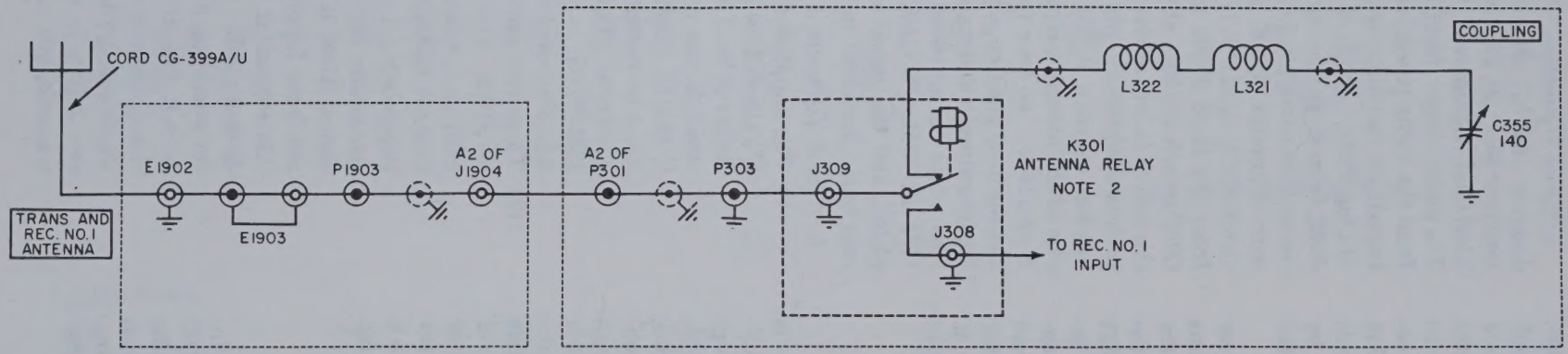
Rf signals are picked up by the antenna and introduced to the input of Radio Receiver R-257/U (par. 84). This input is converted into an audio signal as explained in the receiver block diagram discussion (par. 72). The following subparagraphs deal with the completion of the audio frequency (af) distribution circuits.

a. Local Operation. The simplified schematic diagram (fig. 57) shows how signals from either Receiver No. 1 or Receiver No. 2 are conveyed to Electrical Equipment Cabinet CY–1221(*)/G. The audio output from Receiver No. 1 is coupled from the audio power amplifier (V122), through impedance matching transformer T121, to pin L of plug P121. Pin L of P121 mates with pin L of J262, from where the signal continues to pin 15 of the main receiver plug (P252). Plug P252 mates with connector J1902 in Electrical Equipment Cabinet CY–1221(*)/G. The audio signal goes from pin 15 of J1902 to the INTERCOM. ON-OFF switch (S1906) at pin 2 of section 1. When the switch is left in the OFF position, the signal path is completed to pin 1 of section 1, and to the handset earpiece at pin A of J1907. The other side of the handset earpiece goes to ground at pin B of J1907. To hear the output of Receiver No. 2 at the local position, a jumper must be connected from terminal 8 to terminal 9 of TB1902 (par. 31). The audio circuit from pin 15 of J1901 to the INTERCOM. ON-OFF switch will then be completed, and the signal will reach the handset as previously described in this subparagraph.

b. Remote Operation.

(1) The simplified schematic diagram (fig. 57) shows how audio signals from either Receiver No. 1 or Receiver No. 2 are conveyed to the remote Radio Set Control C–845/U. Audio output from Receiver No. 1 is connected to connector J1902 in Electrical Equipment Cabinet CY–1221(*)/G. Output from Receiver No. 2 is connected to connector J1901.

(2) These two audio outputs are then wired to J1903, which mates with connector P701 on the local control unit, Radio Set Control C–844/U. Audio output from Receiver No. 1 is always connected to the attenuator network that consists of resistors R706, R707, and R708. The output from Receiver No. 2 is connected to this attenuator only when relay K703 is de-energized. (Refer to paragraph 88 for operation of frequency selection circuits.) The circuit continues through the closed contacts of relays K701 and K702 which are also de-energized. One of these two relays is operated only when the transmitter is in operation.



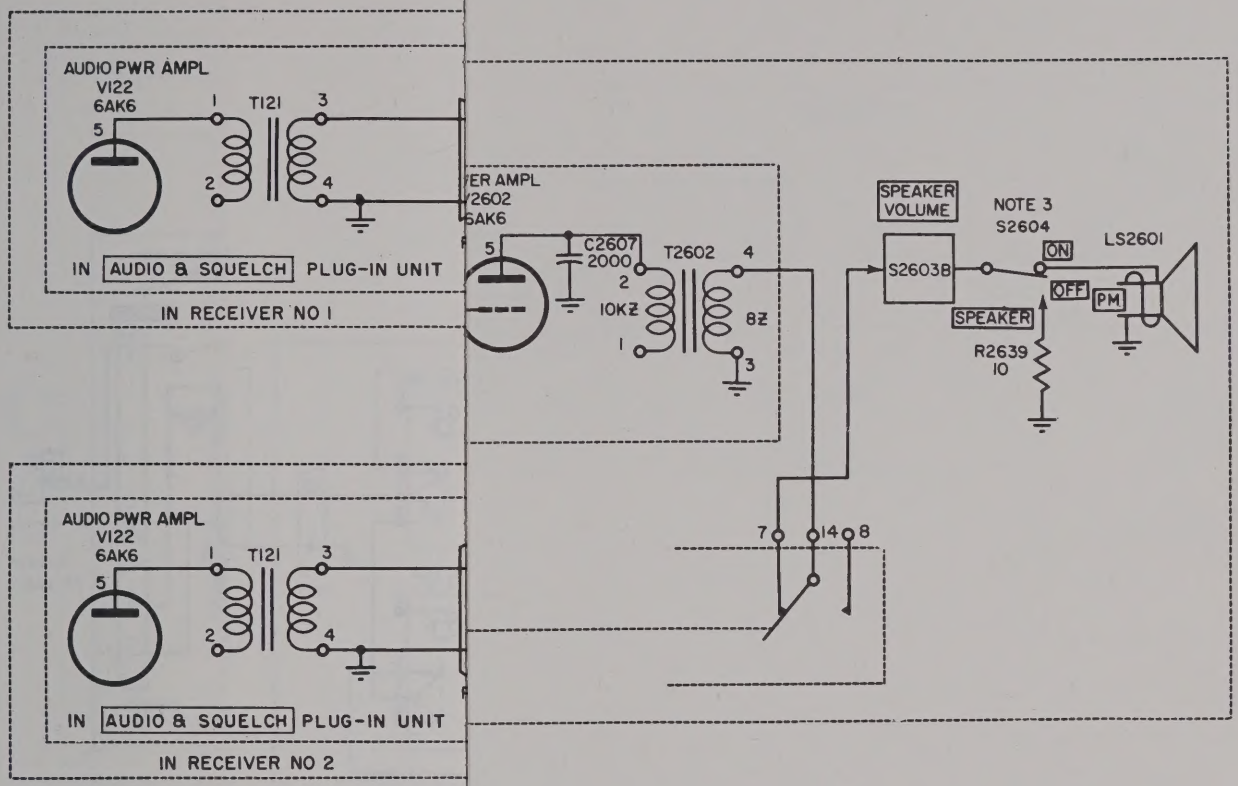
TRANSMITTER ANTENNA CONNECTION

NOTES:

1. THE COMPONENT SYMBOL NUMBERS ARE AS FOLLOWS:
   301 TO 400 RADIO TRANSMITTER T-417/GR, 1900-2000 ELECTRICAL EQUIPMENT CABINET CY-1221(*)/G.
2. RELAY K301 SHOWN ENERGIZED.

TM 282-20

Figure 56. Transmitter rf distribution circuit.



WN:
OHMS,
UUF.

OFF POSITION.

G LOADED TO
POSITION.

PONENTS
OWS:
VER R-257/U.
ONTROL C-844/U.
AL EQUIPMENT
G.
CONTROL C-845/U.

5. RELAY K2602 SHOWN ENERGIZED. RELAYS K701, K702, K703, AND K2601 SHOWN UNENERGIZED.
6. ALL PLUGS VIEWED FROM WIRED SIDE.
7. FOR LOCAL OPERATION USING RECEIVER NO. 2 JUMPER TERMINALS 8 AND 9 ON TB1902.

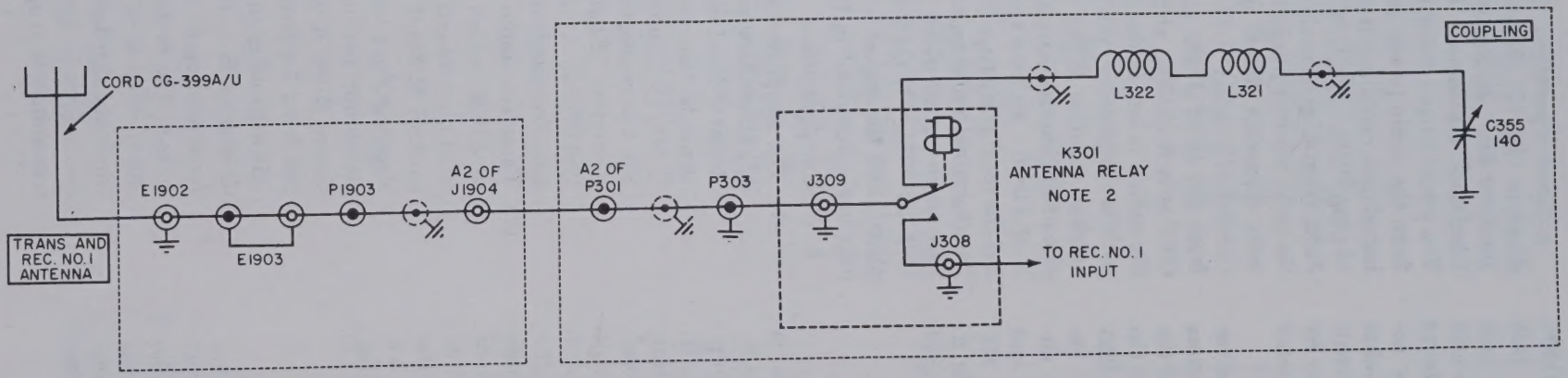


Figure 56. Transmitter rf distribution circuit.

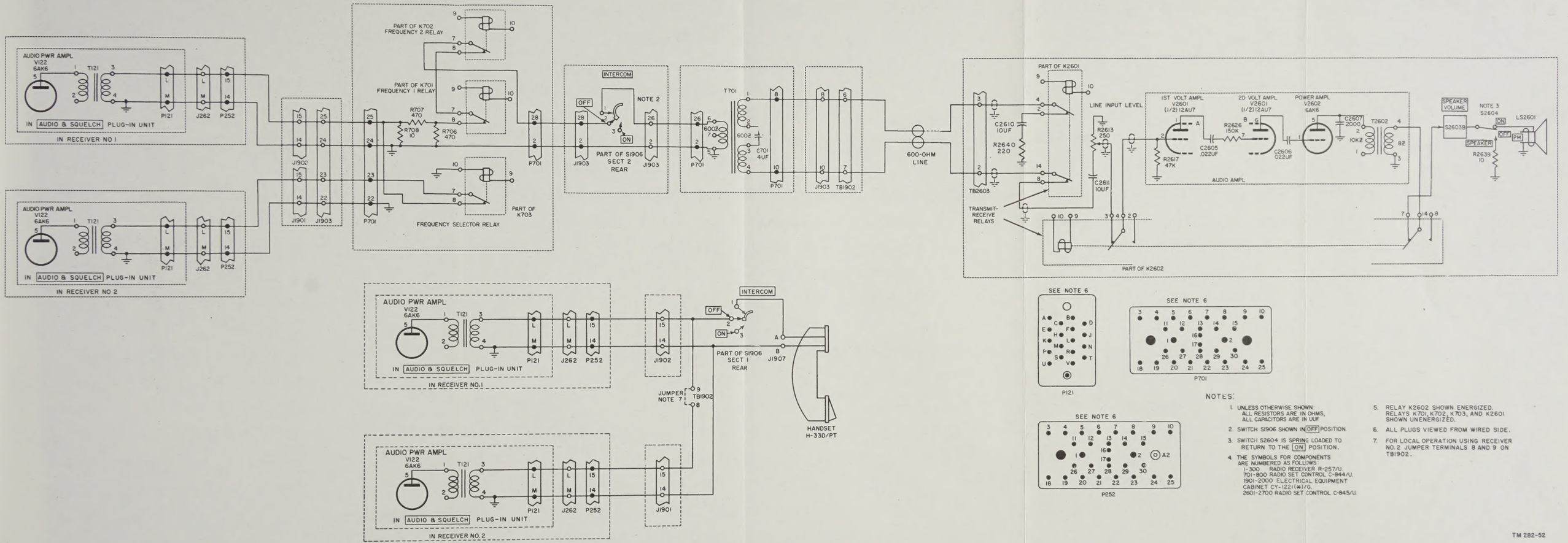
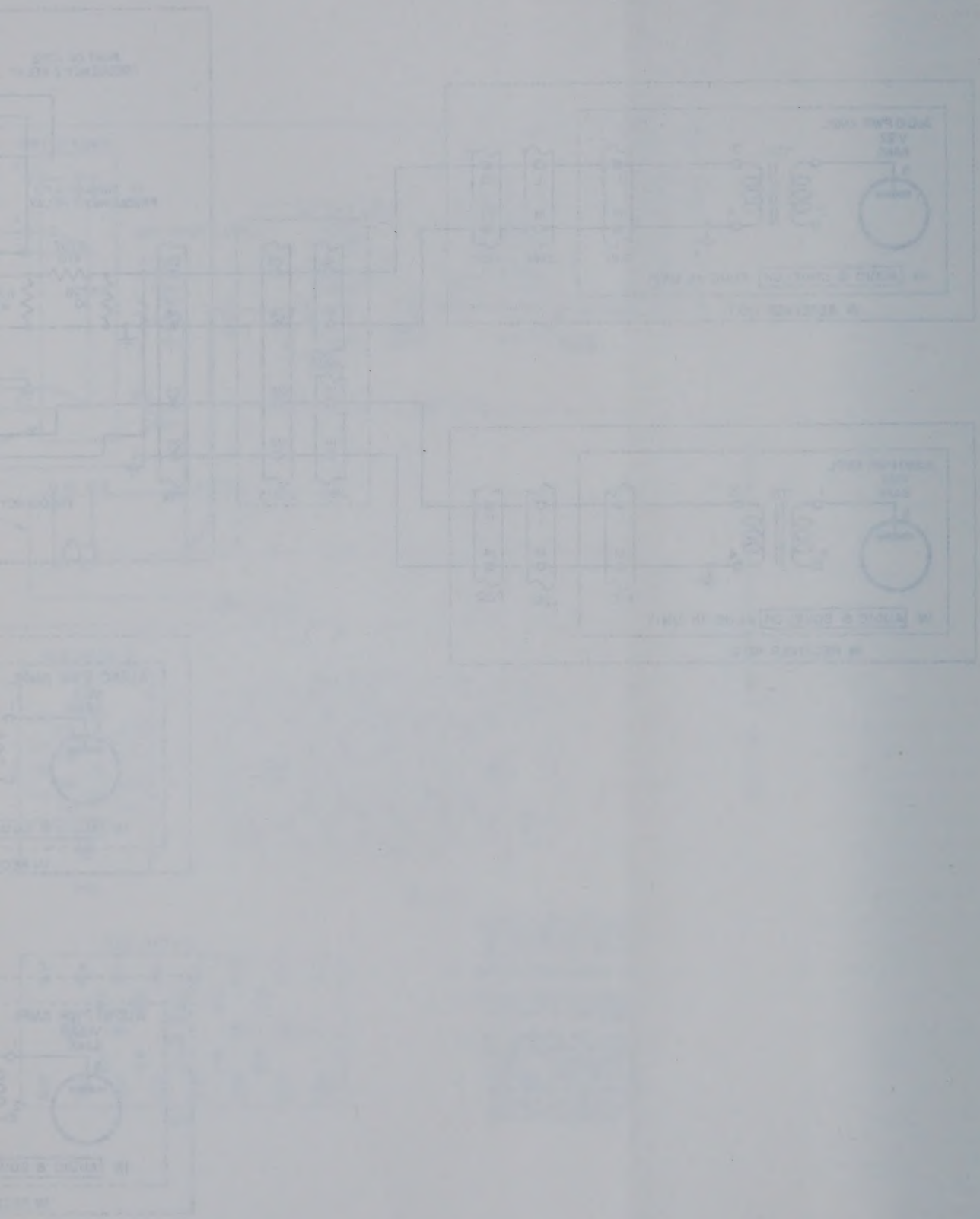
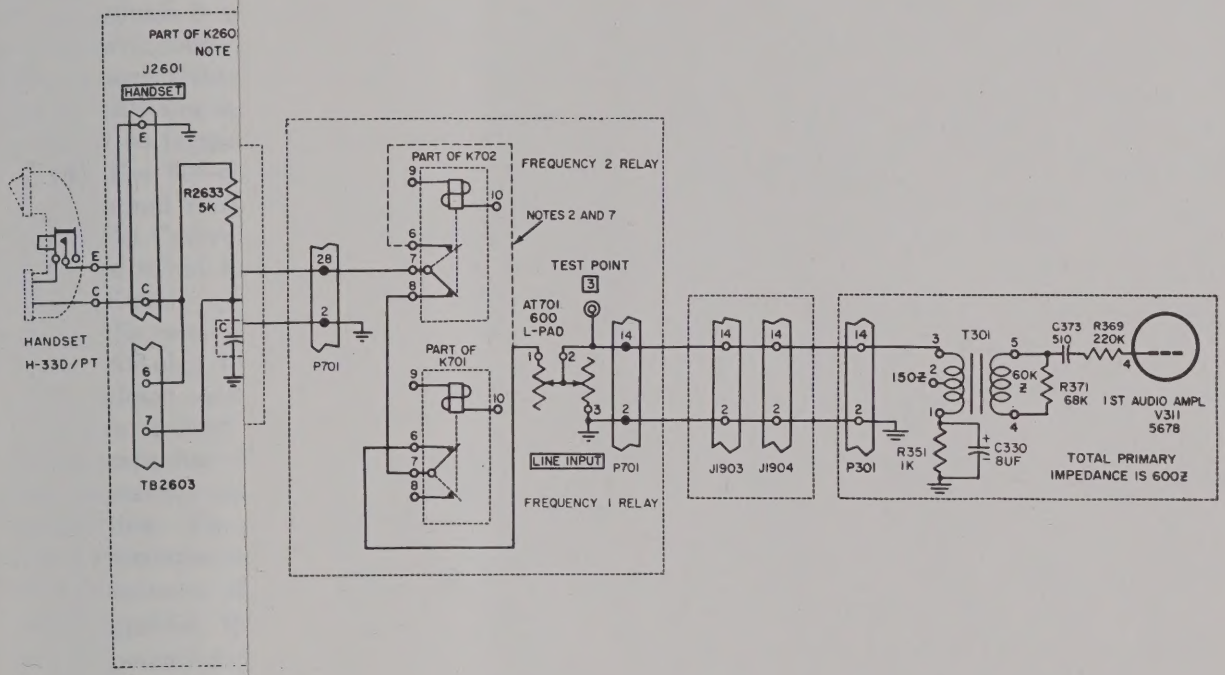


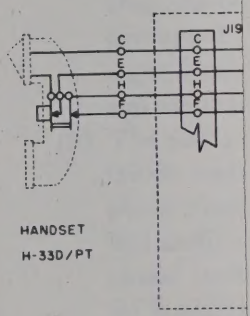
Figure 57. Receiver channel af distribution circuit.

NOTES:

1. UNLESS OTHERWISE SHOWN:
   ALL RESISTORS ARE IN OHMS,
   ALL CAPACITORS ARE IN UUF
2. SWITCH S1906 SHOWN IN OFF POSITION.
3. SWITCH S2604 IS SPRING LOADED TO RETURN TO THE ON POSITION.
4. THE SYMBOLS FOR COMPONENTS ARE NUMBERED AS FOLLOWS:
   1-300 RADIO RECEIVER R-257/U.
   701-800 RADIO SET CONTROL C-844/U.
   1901-2000 ELECTRICAL EQUIPMENT CABINET CY-1221(W)/G.
   2601-2700 RADIO SET CONTROL C-845/U.
5. RELAY K2602 SHOWN ENERGIZED. RELAYS K701, K702, K703, AND K2601 SHOWN UNENERGIZED.
6. ALL PLUGS VIEWED FROM WIRED SIDE.
7. FOR LOCAL OPERATION USING RECEIVER NO. 2 JUMPER TERMINALS 8 AND 9 ON TB1902.







NOTES:

1. UNLESS OTHERWISE SHOWN; ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
2. SOLID CONNECTIONS THROUGH RELAYS K701 AND K702 INDICATE FREQ. 1. BROKEN LINES INDICATE FREQ. 2.
3. SWITCH S2602 SECTION 2 IS SHOWN IN [FREQ. 1 REC. 1] POSITION.
4. SWITCH S1906 SHOWN IN [OFF] POSITION.
5. TERMINALS 6 AND 7 ON TB2603 ARE FURNISHED FOR THE USE OF AN EXTERNAL MICROPHONE.
6. THE SYMBOLS FOR COMPONENTS ARE NUMBERED AS FOLLOWS:
   301-400 RADIO TRANSMITTER T-417/GR.
   701-800 RADIO SET CONTROL C-844/U.
   1901-2000 ELECTRICAL EQUIPMENT CABINET CY-1221(*)/G.
   2601-2700 RADIO SET CONTROL C-845/U.
7. RELAY K2601 SHOWN ENERGIZED RELAY K2602 SHOWN UNENERGIZED RELAY K702 SHOWN ENERGIZED WITH BROKEN LINES.
8. CONNECTORS VIEWED FROM WIRED SIDE.

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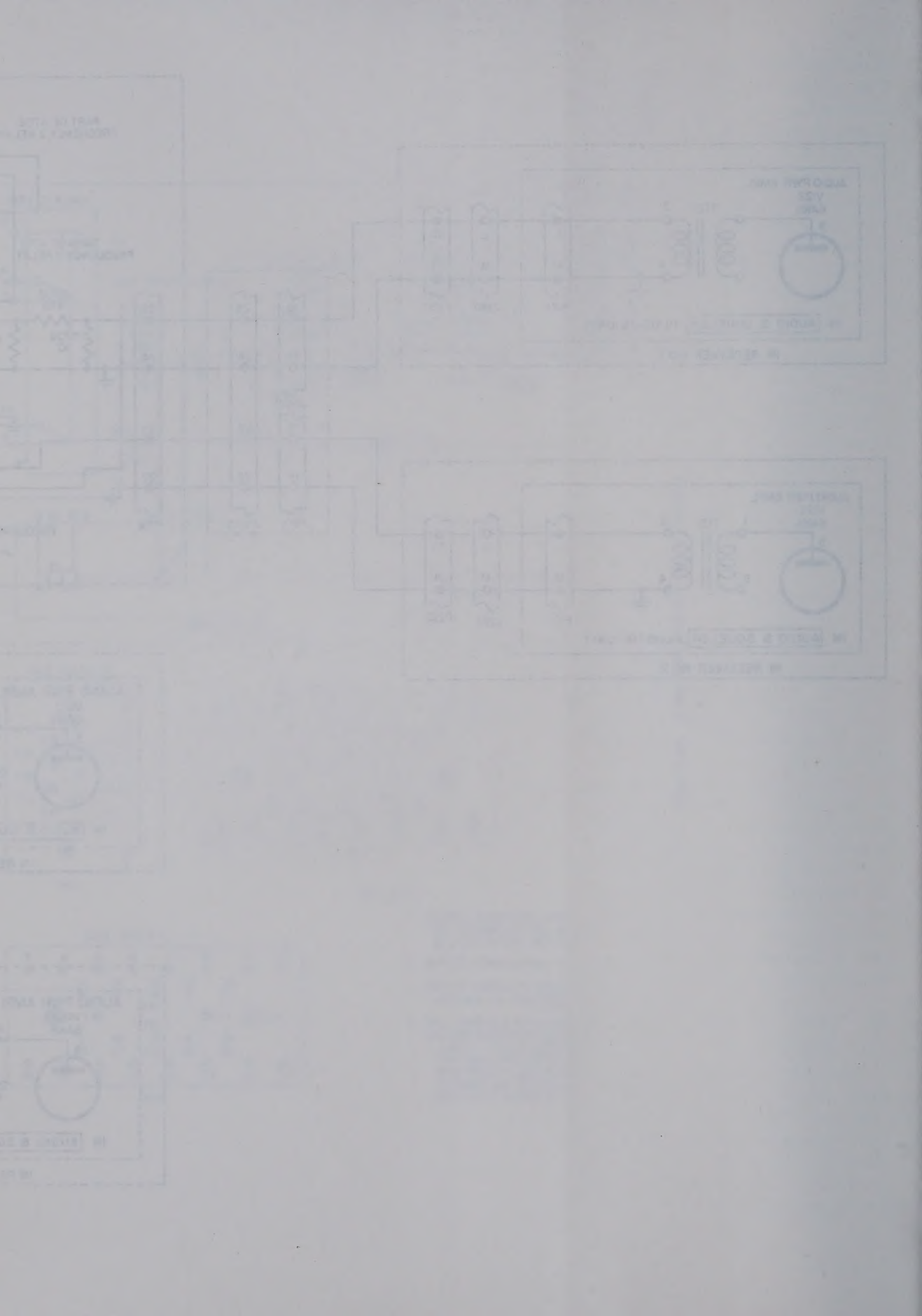

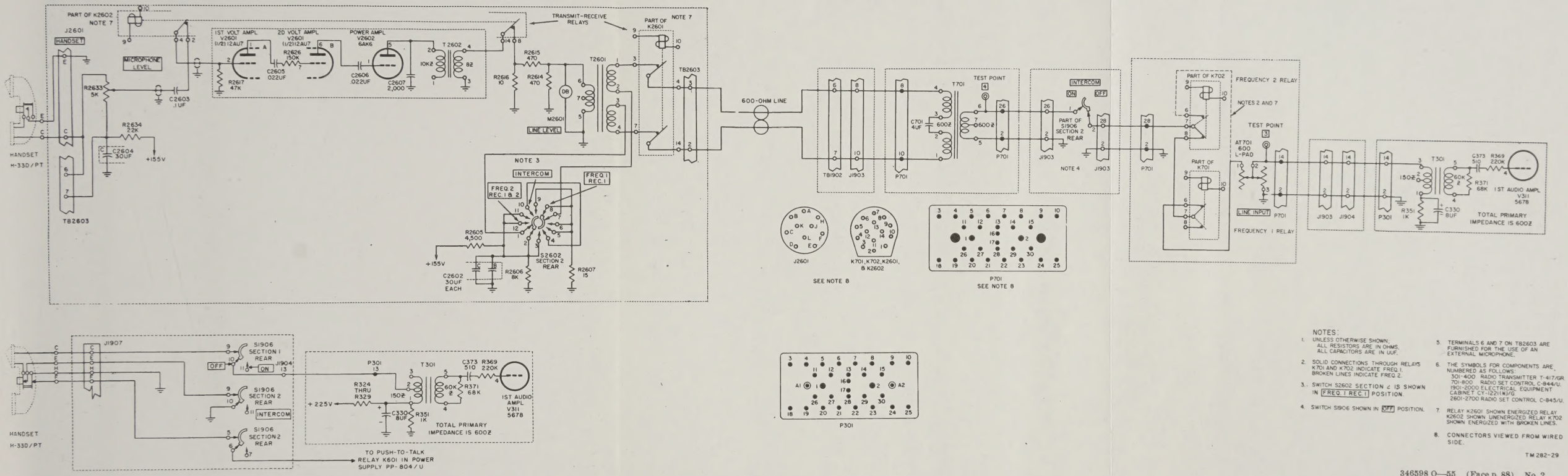

Figure 58. Transmit channel af distribution circuit.

NOTES:

1. UNLESS OTHERWISE SHOWN, ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
2. SOLID CONNECTIONS THROUGH RELAYS K701 AND K702 INDICATE FREQ 1. BROKEN LINES INDICATE FREQ 2.
3. SWITCH S2602 SECTION 2 IS SHOWN IN FREQ 1 REC 1 POSITION.
4. SWITCH S1906 SHOWN IN OFF POSITION.
5. TERMINALS 6 AND 7 ON TB2603 ARE FURNISHED FOR THE USE OF AN EXTERNAL MICROPHONE.
6. THE SYMBOLS FOR COMPONENTS ARE NUMBERED AS FOLLOWS:
   - 301-400 RADIO TRANSMITTER T-417/GR
   - 701-800 RADIO SET CONTROL C-844/U.
   - 1901-2000 ELECTRICAL EQUIPMENT CABINET CY-1121(V)/G
   - 2601-2700 RADIO SET CONTROL C-845/U.
7. RELAY K2601 SHOWN ENERGIZED RELAY K2602 SHOWN UNENERGIZED RELAY K702 SHOWN ENERGIZED WITH BROKEN LINES.
8. CONNECTORS VIEWED FROM WIRED SIDE.

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(3) The audio output signal is conveyed out of the local Radio Set Control C–844/U, through connector P701, to connector J1903. When spring-loaded INTERCOM. ON-OFF switch S1906 is left at the OFF position, the audio circuit is completed to terminal 26 of J1903, and then to P701 in the local control unit. The audio signal is then coupled into line transformer T701. The secondary of this transformer is connected to terminals 8 and 10 of P701, which mates with connector J1903 in Electrical Equipment Cabinet CY–1221(*)/G. The 600-ohm line is connected to terminals 6 and 7 on terminal board TB1902.

(4) The 600-ohm line is connected to terminal board TB2603 in the remote Radio Set Control C–845/U. The audio signal is wired through the contacts of relay K2601. (Relay K2601 is de-energized in the receive condition.) One leg of the 600-ohm line is connected to a pair of closed contacts on relay K2601, and goes to ground through resistor R2640 and capacitor C2610. The resistor partly matches the impedance of the 600-ohm line. The other leg of the 600-ohm line is connected through another set of closed contacts of relay K2601, and then to ground, through capacitor C2611 and potentiometer R2613, which is a 250-ohm line input level control. The audio signal from the potentiometer is then connected through a pair of closed contacts on energized relay K2602, to the grid of voltage amplifier tube V2601.

(5) The audio signal is amplified by the two triode sections of tube V2601, and by power amplifier tube V2602. The amplified audio signal passes through a set of closed contacts on relay K2602 to the SPEAKER VOLUME switch (S2603-B). The audio signal is then applied through SPEAKER ON-OFF switch S2604, which is spring-loaded in the ON position, to loudspeaker LS2601. When switch S2604 is in the OFF position, resistor R2639 applies a 10-ohm resistive load to the secondary of audio output transformer T2602.

87. Transmit Circuits

(fig. 58)

Rf signals from Radio Transmitter T–417/GR are connected to the system antenna (par. 85). The operation of this unit is discussed in paragraph 73. Subparagraphs *a* and *b* below discuss the af distribution circuit from the remote control unit to the transmitter.

a. Local Operation. The simplified schematic diagram (fig. 58) shows how the signal from the handset at the local position modulates the transmitter. The signal originating at the handset microphone is fed from pin C of J1907 to pin 9, section 1, of the spring-loaded INTERCOM. ON-OFF switch S1906 in Electrical Equipment Cabinet CY–1221(*)/G. When the switch is in the OFF position, the signal path is completed through the switch, and then to pin 13 of connector J1904. Connector J1904 mates with plug P301 on Radio Transmitter T–417/GR. The signal continues through pin 13 of plug P301, to transformer T301. Resistor R371 provides a constant load on the secondary winding of transformer T301. Resistor R369 and capacitor C373 couple the audio signal to the grid of first audio amplifier V311. The other side of the handset microphone goes to ground from pin E of J1907, through the INTERCOM. ON-OFF switch, at pins 9 and 10, section 2. The voltage required for operation of the carbon microphone is obtained across resistor R351 in Radio Transmitter T–417/GR. Capacitor C330 by-passes R351 for af. The push-to-talk relay in Power Supply PP–804/U is energized when the push-to-talk switch on the handset is pressed. The circuit is completed from the push-to-talk relay to the INTERCOM. ON-OFF switch at pin 6 of section 2. When the switch is in the OFF position, the circuit continues to pin 5, section 2, and then to pin F on J1907. The push-to-talk switch in the handset completes the circuit to pin H of J1907, which is grounded.

b. Remote Operation.

(1) The handset is connected to connector J2601 of Radio Set Control C–845/U, and the audio signal is fed to MICROPHONE LEVEL control R2633, which is adjusted to give optimum signal input to the three-stage audio amplifier. Relay K2602 is de-energized when the push-to-talk button on the handset is operated. The output of the amplifier passes

through the attenuator, consisting of resistors R2614, R2615, and R2616. The signal is then coupled through line transformer T2601, to relay K2601, which is energized as shown. A 600-ohm line ties in at terminal board TB2603, which transfers the audio signal to terminal board TB1902 in Electrical Equipment Cabinet CY–1221(*)/G. Mating connectors J1903 and P701 feed the signal to line transformer T701 in Radio Set Control C–844/U.

(2) Capacitor C701 appears as a closed circuit to an audio signal, thereby completing the circuit through the input windings of transformer T701. The audio signal is then routed through mating connectors P701 and J1903 to the INTERCOM. ON-OFF switch, which is shown in the OFF position.

(3) The operation of relays K701 and K702 is such that when the remote handset is keyed, one of the relays is energized, while the other is de-energized, depending on which one of the two operating frequencies is used. This sequence of operations permits the audio signal to continue to the LINE INPUT control AT701, an L-pad attenuator, which maintains a constant load impedance for the 600-ohm line. Resistor R371 provides a constant load for the secondary winding of transformer T301. Resistor R369 and capacitor C373 couple the audio signal into the grid of first audio amplifier V311.

(4) Terminal board TB2603, in Radio Set Control C–845/U permits the use of an external microphone or handset. The dc voltage required for operating a carbon microphone, such as the one in Handset H–33D/PT, is supplied from the +155-volt output of *plug-in* Power Supply PP–846/U, through series-dropping resistor R2634, and MICROPHONE LEVEL control R2633. Capacitor C2604C by-passes R2634 and the power supply to ground for audio signals. The audio signal level is measured with LINE LEVEL meter M2601. This meter is calibrated in units of dbm and is normally adjusted for −2 dbm.

Note. Dbm is an audio power level referenced to 1 milliwatt of audio power, developed across a 600-ohm load.

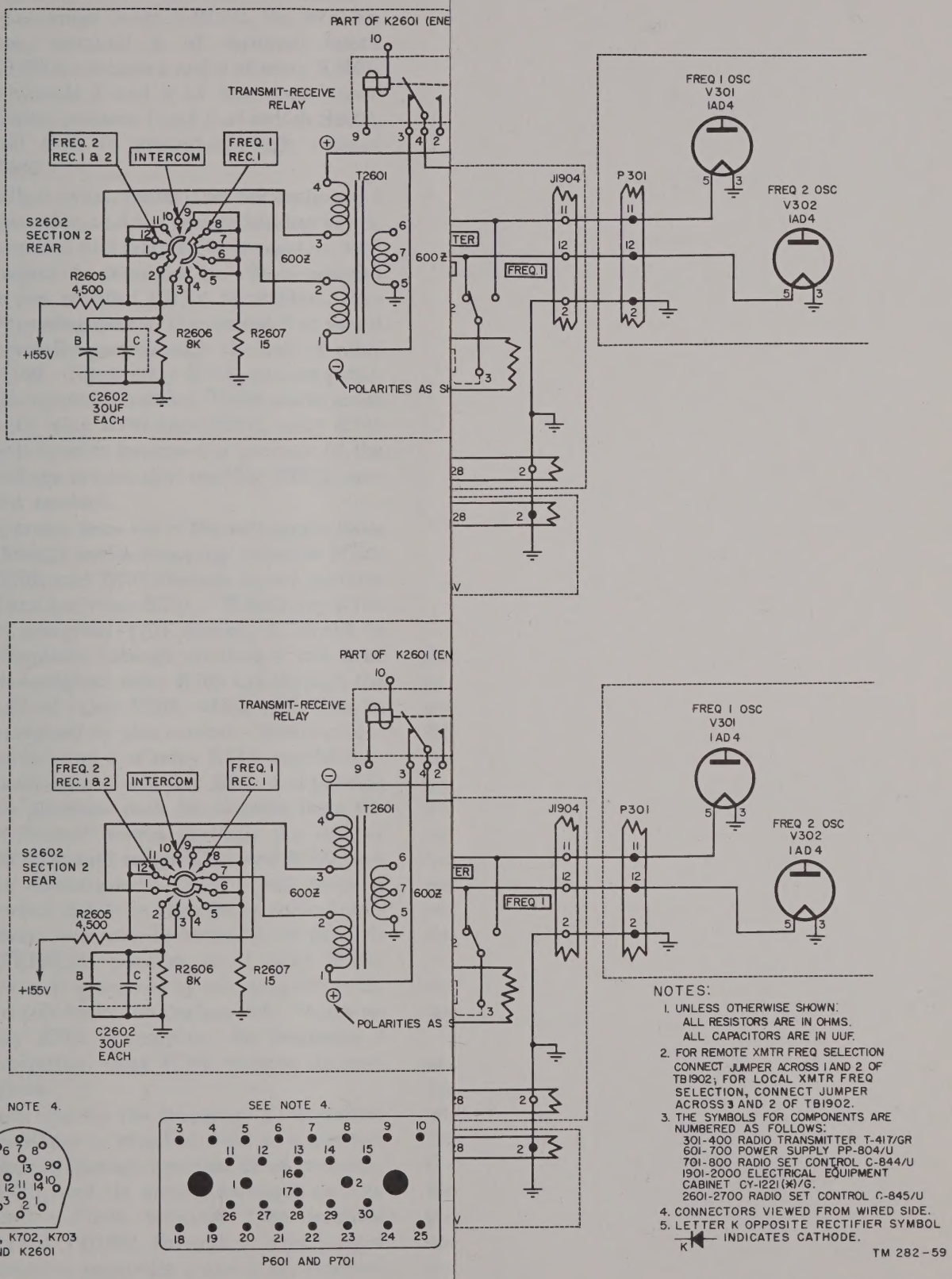
(5) Switch S2602 is used for selecting FREQ. 1 REC. 1, FREQ. 2 REC. 1 and 2, or INTERCOM operation. This switch completes a signal path between terminals 2 and 3 of transformer T2601. When it is switched to the INTERCOM position, no dc polarizing voltage is placed on the 600-ohm line. When set to either of the other two positions, a dc polarizing voltage is impressed on the 600-ohm line, when the handset push-to-talk switch is pressed. A complete description of the action of switch S2602 is given in paragraph 78*f* and *g*. Resistors R2605, R2606, and R2607 reduce the dc polarizing voltage to the proper level, and capacitors C2602B and C2602C by-pass R2606 for audio signals.

88. Frequency Selection Circuits

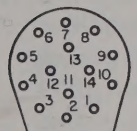
a. Figure 59 shows two functional diagrams that indicate how the transmitter can be operated on either of two crystal-controlled frequencies, from a remote location, with Radio Set Control C–845/U, or from the local position at the transmitter. The upper half of the illustration shows the connections for remote frequency 1 operation, and the lower half shows the connections for remote frequency 2 operation.

b. When switch S2602 is in the FREQ. 1 REC. 1 position, a voltage from the junction of resistors R2605 and R2606 sends current through contacts 2 and 1 on switch S2602, terminals 3 and 4 of transformer T2601, through closed contacts 7 and 14 of transmit-receive relay K2601, terminal 2 on terminal board TB2603, through the 600-ohm line, terminal 7 of terminal board TB1902, terminal 10 of connectors J1903 and P701, terminals 4 and 3 of transformer T701, to terminal 10 of the frequency 1 relay (K701).

(1) Figure 59 shows that relays K701 and K702 have their coils connected in series, and that a rectifier is connected across each coil (CR701 and CR702). The circuit is traced from terminal 10 of K701 through the two relays to terminals 2 and



SEE NOTE 4.



K701, K702, K703 AND K2601

SEE NOTE 4.

P601 AND P701

NOTES:

1. UNLESS OTHERWISE SHOWN:
   ALL RESISTORS ARE IN OHMS.
   ALL CAPACITORS ARE IN UUF.
2. FOR REMOTE XMTR FREQ SELECTION CONNECT JUMPER ACROSS 1 AND 2 OF TB1902; FOR LOCAL XMTR FREQ SELECTION, CONNECT JUMPER ACROSS 3 AND 2 OF TB1902.
3. THE SYMBOLS FOR COMPONENTS ARE NUMBERED AS FOLLOWS:
   301-400 RADIO TRANSMITTER T-417/GR
   601-700 POWER SUPPLY PP-804/U
   701-800 RADIO SET CONTROL C-844/U
   1901-2000 ELECTRICAL EQUIPMENT CABINET CY-1221(*)/G.
   2601-2700 RADIO SET CONTROL C-845/U
4. CONNECTORS VIEWED FROM WIRED SIDE.
5. LETTER K OPPOSITE RECTIFIER SYMBOL INDICATES CATHODE.

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through the attenuator, consisting of resistors R2614, R2615, and R2616. The signal is then coupled through line transformer T2601, to relay K2601, which is energized as shown. A 600-ohm line ties in at terminal board TB2603, which transfers the audio signal to terminal board TB1902 in Electrical Equipment Cabinet CY–1221(*)/G. Mating connectors J1903 and P701 feed the signal to line transformer T701 in Radio Set Control C–844/U.

(2) Capacitor C701 appears as a closed circuit to an audio signal, thereby completing the circuit through the input windings of transformer T701. The audio signal is then routed through mating connectors P701 and J1903 to the INTERCOM. ON-OFF switch, which is shown in the OFF position.

(3) The operation of relays K701 and K702 is such that when the remote handset is keyed, one of the relays is energized, while the other is de-energized, depending on which one of the two operating frequencies is used. This sequence of operations permits the audio signal to continue to the LINE INPUT control AT701, an L-pad attenuator, which maintains a constant load impedance for the 600-ohm line. Resistor R371 provides a constant load for the secondary winding of transformer T301. Resistor R369 and capacitor C373 couple the audio signal into the grid of first audio amplifier V311.

(4) Terminal board TB2603, in Radio Set Control C–845/U permits the use of an external microphone or handset. The dc voltage required for operating a carbon microphone, such as the one in Handset H–33D/PT, is supplied from the +155-volt output of *plug-in* Power Supply PP–846/U, through series-dropping resistor R2634, and MICROPHONE LEVEL control R2633. Capacitor C2604C by-passes R2634 and the power supply to ground for audio signals. The audio signal level is measured with LINE LEVEL meter M2601. This meter is calibrated in units of dbm and is normally adjusted for −2 dbm.

Note. Dbm is an audio power level referenced to 1 milliwatt of audio power, developed across a 600-ohm load.

(5) Switch S2602 is used for selecting FREQ. 1 REC. 1, FREQ. 2 REC. 1 and 2, or INTERCOM operation. This switch completes a signal path between terminals 2 and 3 of transformer T2601. When it is switched to the INTERCOM position, no dc polarizing voltage is placed on the 600-ohm line. When set to either of the other two positions, a dc polarizing voltage is impressed on the 600-ohm line, when the handset push-to-talk switch is pressed. A complete description of the action of switch S2602 is given in paragraph 78*f* and *g*. Resistors R2605, R2606, and R2607 reduce the dc polarizing voltage to the proper level, and capacitors C2602B and C2602C by-pass R2606 for audio signals.

88. Frequency Selection Circuits

a. Figure 59 shows two functional diagrams that indicate how the transmitter can be operated on either of two crystal-controlled frequencies, from a remote location, with Radio Set Control C–845/U, or from the local position at the transmitter. The upper half of the illustration shows the connections for remote frequency 1 operation, and the lower half shows the connections for remote frequency 2 operation.

b. When switch S2602 is in the FREQ. 1 REC. 1 position, a voltage from the junction of resistors R2605 and R2606 sends current through contacts 2 and 1 on switch S2602, terminals 3 and 4 of transformer T2601, through closed contacts 7 and 14 of transmit-receive relay K2601, terminal 2 on terminal board TB2603, through the 600-ohm line, terminal 7 of terminal board TB1902, terminal 10 of connectors J1903 and P701, terminals 4 and 3 of transformer T701, to terminal 10 of the frequency 1 relay (K701).

(1) Figure 59 shows that relays K701 and K702 have their coils connected in series, and that a rectifier is connected across each coil (CR701 and CR702). The circuit is traced from terminal 10 of K701 through the two relays to terminals 2 and

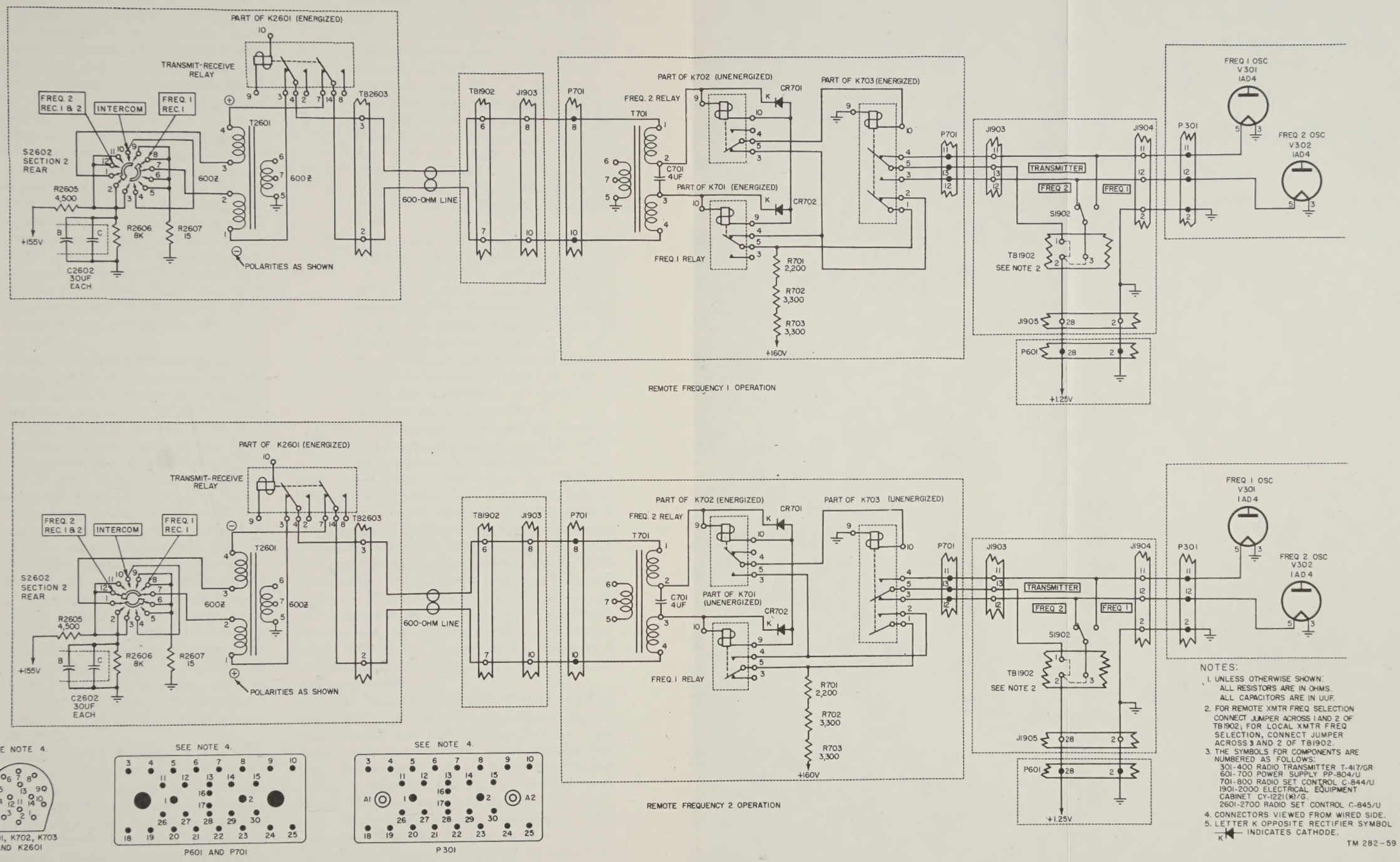


Figure 59. Frequency changing, schematic diagram.

1 of transformer T701, to terminals 8 of connectors P701 and J1903, terminal 6 of terminal board TB1902, the 600-ohm line, terminal 3 of terminal board TB2603, contacts 4 and 3 of relay K2601, terminals 1 and 2 of line transformer T2601, contacts 7 and 8 of switch S2602, and then to ground through resistor R2607.

(2) When switch S2602 is set for frequency 1 operation, and the remote handset keyed, terminal 9 of relay K702 is negative with respect to terminal 10. This polarity causes rectifier CR701 to conduct, thus bypassing most of the current that would normally pass through the coil of relay K702. Since relay K701, and its parallel-connected rectifier CR702 are in series with relay K702 and CR701, relay K701 will operate because the polarity of the voltage is such that rectifier CR702 cannot conduct.

(3) Current from the +160-volt source flows through series-dropping resistors R703, R702, and R701 through closed contacts 5 and 4 of relay K701. When relay K701 is energized ((2) above), a circuit is completed through contacts 3 and 5 of de-energized relay K702 and through the coil of relay K703, which will then be energized by this current. Holding contacts 1 and 2 of relay K703 parallel contacts 4 and 5 of relay K701 and provide an alternate path for current from the +160-volt source through the coil of K703 should relays K701 and K702 both be de-energized. This would occur if switch S2602 in the remote control unit were momentarily switched to the INTERCOM position, or if relay K2601 were de-energized by releasing the push-to-talk button on the handset. When relay K702 is energized for frequency 2 operation, relay K703 remains de-energized.

(4) Current for the frequency 1 transmitter oscillator is supplied from a +1.25-volt source, through terminal 28 of connector P601, and its mating terminal on connector J1905, terminal 2 on terminal board TB1902, through a wire jumper between terminals 1 and 2 on terminal board TB1902, terminals 13 of connectors J1903 and P701, closed contacts 5 and 4 of relay K703, terminals 11 of connectors P701, J1903, J1904, and P301, and through the filament of oscillator V301. When switch S2602 is set for frequency 2 operation, relay K701 is de-energized, relay K702 is energized, and its contacts 4 and 5 open to de-energized relay K703. When K703 is de-energized, current from the +1.25-volt source flows through closed contacts 5 and 3 of K703, terminals 12 of connectors P701, J1903, J1904, and P301, through the filament of oscillator V302.

(5) If terminals 2 and 3 on terminal board TB1902, instead of terminals 1 and 2, are tied together by a jumper, switch S2602 in the remote control unit will no longer control the frequency of operation; instead the setting of switch S1902 in Electrical Equipment Cabinet CY–1221-(*)/G will select the frequency of transmission by switching the +1.25 volts to either the frequency 1 or frequency 2 oscillator in the transmitter.

c. The circuit in the lower half of figure 59 shows remote frequency 2 operation, and is similar to the circuit discussed in *a* and *b* above. However, switch S2602 is now set in the FREQ. 2 REC. 1 and 2 position, and the positive voltage from the junction of resistors R2605 and R2606 is now applied to the lower winding at terminal 2 of transformer T2601. Consequently, the polarity on the 600-ohm line is reversed, and relay K702 is energized. Relay K701 is de-energized because rectifier CR702 now conducts and by-passes current around relay K701. Relay K703 will also be de-energized, and contacts 3 and 5 will connect +1.25 volts to the filament in the frequency 2 oscillator, if terminal board TB1902 is wired for remote operation.

d. The voltage at the junction of resistors R2605 and R2606 is the line-polarizing voltage. Capacitors C2602B and C2602C filter out any hum which might be transmitted on the 600-ohm line from the power supply in Radio Set Control C–845/U. Since this 600-ohm line and line transformer T701 carry audio signals in addition to the polarizing voltage, this hum could impair audio operation. Capacitor C701 connects terminals 2 and 3 of transformer T701 together for audio volt-

ages, but appears as an open circuit to the dc polarizing voltage. When switch S2602 is set in the INTERCOM position, terminals 2 and 3 of transformer T2601 are connected together, thus completing the audio circuit in the absence of the polarizing voltage.

89. Push-to-Talk Circuits

a. General. The push-to-talk feature of Radio Set AN/FRC–15 automatically mutes the receiver (if muting is desired), and completes the transmission circuit by a single control, the push-to-talk switch of the system handset. Figure 60 shows the B+ distribution which is required to change system operation from reception to transmission. There are several different circuits which permit push-to-talk relay K601 to be energized. The circuits for controlling relay K601, and the circuits controlled by relay K601, are described in the following subparagraphs.

b. Push-to-talk Relay. Relay K601 in Power Supply PP–804/U is the push-to-talk relay. It is energized by grounding one side of its coil, thus completing a 6.5-vole circuit from rectifier CR606. Energizing the relay completes the following circuits:

(1) Power is applied through contacts 7 and 6 and contacts 2 and 3 of relay K601, to transformer T601 and rectifiers CR601, through CR605 in Power Supply PP–804/U, which in turn provides dc outputs from plug P601. Jacks J1905 and J1904, in Electrical Equipment Cabinet CY–1221(*)/G, connect this dc power to plug P301 of Radio Transmitter T–417/GR for distribution to the bias, plate, and screen grid circuits of the transmitter.

(2) Contacts 5 and 4 close to complete a 90-volt dc circuit from a voltage divider network in the transmitter to terminal 2 of terminal board TB1901 in Electrical Equipment Cabinet CY–1221(*)/G. A jumper, connected across terminals 2 and 3, connect the 90 volts dc to the squelch circuit of Receiver No. 1. This voltage will mute the receiver by causing the squelch circuit to bias the audio circuits beyond cutoff. Connecting the jumper across terminals 2 and 1 will mute Receiver No. 2.

(3) The 90-volt dc used for muting the receiver is also employed as plate voltage for the oscillator and phase modulator tubes in the transmitter. Contacts 5 and 4 of relay K601 complete the circuit from terminal 27 to terminal 26 of transmitter plug P301, thus placing the transmitter in operation.

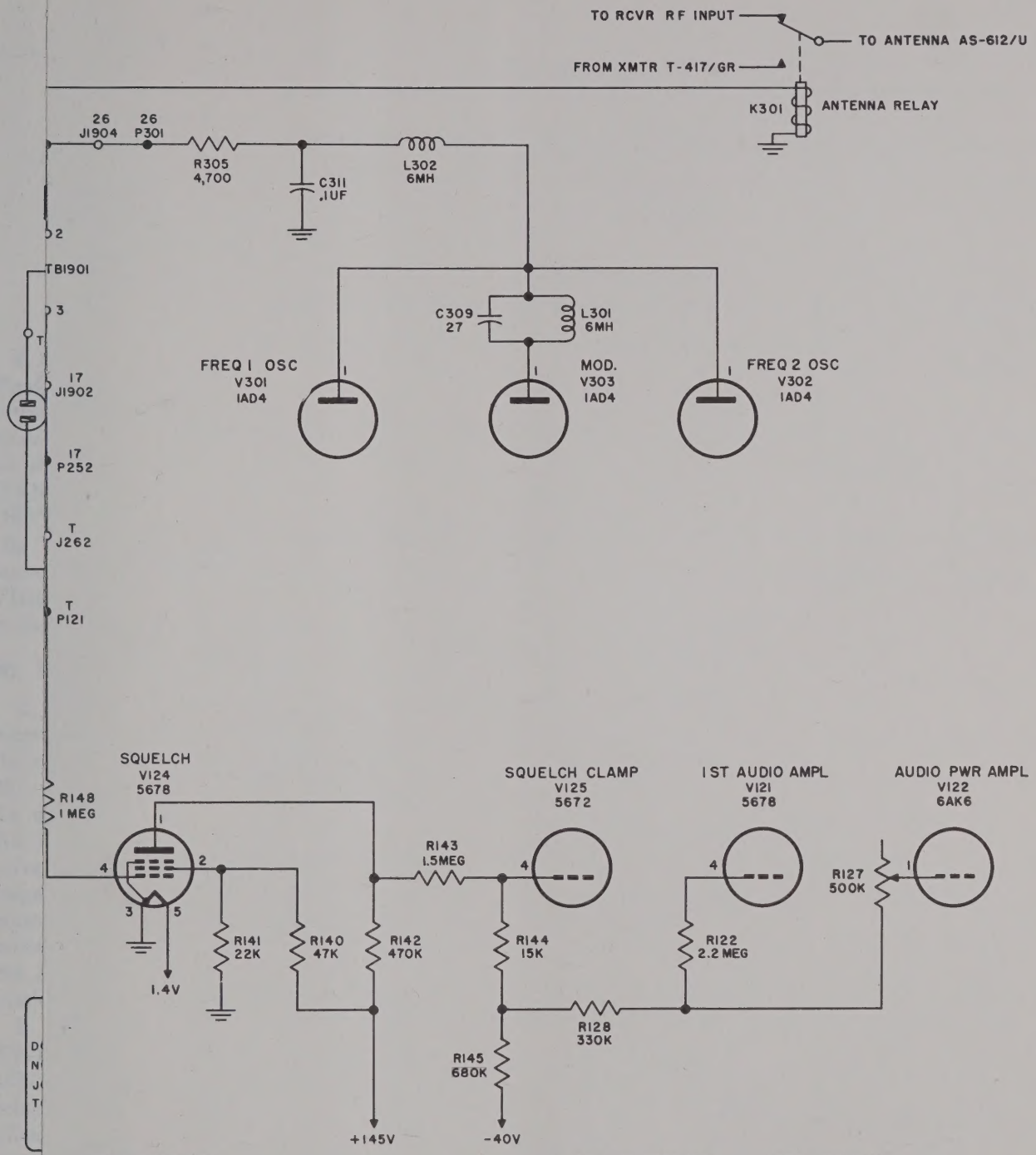
(4) Contacts 8 and 9 close to apply 6.5 volts dc from the output of rectifier CR606 to the coil of antenna relay K301 in the transmitter. This voltage energizes the antenna relay, and its contacts switch the antenna connection at jack J309 from the receiver rf input to the output of the transmitter.

c. Push-to-Talk Operation from Radio Set Control C–845/U. When the push-to-talk button on Handset H–33D/PT at the remote control unit is operated, transmit-receive relay K2601 is energized by grounding terminal 9 on the relay (fig. 79). Resistors R2602, R2603, and R2604 are series-dropping resistors which limit the coil current.

(1) When relay K2601 is energized, neon TRANSMIT lamp I2601 is illuminated by the application of +160 volts through closed relay contacts 1 and 12, and current-limiting resistor R2609.

(2) With switch S2602 set in the FREQ. 1 REC. 1 or the FREQ. 2 REC. 1 and 2 position, a polarizing voltage is applied to the 600-ohm line, through line transformer T2601 and closed contacts (3 and 4, and 7 and 14) on relay K2601. This polarizing voltage operates either the frequency 1 or frequency 2 relay in Radio Set Control C–844/U at the local position (fig. 78). Rectifiers CR701 and CR702, connected across the coils of relay K701 and K702, are polarized to by-pass the frequency 1 relay coil, if switch S2602 is set in the FREQ. 2 REC. 1 and 2 position. Conversely, the frequency 2 relay is by-passed if this switch is placed in the FREQ. 1 REC. 1 position.

(3) With switch S2602 in either FREQ. 1 REC. 1 or the FREQ. 2 REC. 1 and 2 position, the polarizing voltage is applied to relay K701 or relay K702 in Radio Set Control C–844/U only when receive-transmit relay K2601 at Radio Set Control C–845/U is energized by pressing the remote handset push-to-talk switch



SS OTHERWISE SPECIFIED:
LL RESISTORS ARE IN OHMS,
LL CAPACITORS ARE IN UUF.

COMPONENT SYMBOL NUMBERS ARE AS FOLLOWS:
300 RADIO RECEIVER R-257/U,
DI-400 RADIO TRANSMITTER T-417/GR,
DI-700 POWER SUPPLY PP-804/U,
PDI-800 RADIO SET CONTROL C-844/U,
00-2000 ELECTRICAL EQUIPMENT CABINET CY-1221/G.

3. TO MUTE RECEIVER NO. 1, JUMPER TERMINAL 2 TO 3 ON TB1901. TO MUTE RECEIVER NO. 2, JUMPER TERMINAL 1 TO 2 ON TB1901.
4. FOR RETRANSMISSION JUMPER TERMINAL 6 TO 7 AND 8 TO 10 ON TB1901.
5. ALL PLUGS AND JACKS VIEWED FROM WIRED SIDE.

ages, but appears as an open circuit to the dc polarizing voltage. When switch S2602 is set in the INTERCOM position, terminals 2 and 3 of transformer T2601 are connected together, thus completing the audio circuit in the absence of the polarizing voltage.

89. Push-to-Talk Circuits

a. General. The push-to-talk feature of Radio Set AN/FRC–15 automatically mutes the receiver (if muting is desired), and completes the transmission circuit by a single control, the push-to-talk switch of the system handset. Figure 60 shows the B+ distribution which is required to change system operation from reception to transmission. There are several different circuits which permit push-to-talk relay K601 to be energized. The circuits for controlling relay K601, and the circuits controlled by relay K601, are described in the following subparagraphs.

b. Push-to-talk Relay. Relay K601 in Power Supply PP–804/U is the push-to-talk relay. It is energized by grounding one side of its coil, thus completing a 6.5-vole circuit from rectifier CR606. Energizing the relay completes the following circuits:

(1) Power is applied through contacts 7 and 6 and contacts 2 and 3 of relay K601, to transformer T601 and rectifiers CR601, through CR605 in Power Supply PP–804/U, which in turn provides dc outputs from plug P601. Jacks J1905 and J1904, in Electrical Equipment Cabinet CY–1221(*)/G, connect this dc power to plug P301 of Radio Transmitter T–417/GR for distribution to the bias, plate, and screen grid circuits of the transmitter.

(2) Contacts 5 and 4 close to complete a 90-volt dc circuit from a voltage divider network in the transmitter to terminal 2 of terminal board TB1901 in Electrical Equipment Cabinet CY–1221(*)/G. A jumper, connected across terminals 2 and 3, connect the 90 volts dc to the squelch circuit of Receiver No. 1. This voltage will mute the receiver by causing the squelch circuit to bias the audio circuits beyond cutoff. Connecting the jumper across terminals 2 and 1 will mute Receiver No. 2.

(3) The 90-volt dc used for muting the receiver is also employed as plate voltage for the oscillator and phase modulator tubes in the transmitter. Contacts 5 and 4 of relay K601 complete the circuit from terminal 27 to terminal 26 of transmitter plug P301, thus placing the transmitter in operation.

(4) Contacts 8 and 9 close to apply 6.5 volts dc from the output of rectifier CR606 to the coil of antenna relay K301 in the transmitter. This voltage energizes the antenna relay, and its contacts switch the antenna connection at jack J309 from the receiver rf input to the output of the transmitter.

c. Push-to-Talk Operation from Radio Set Control C–845/U. When the push-to-talk button on Handset H–33D/PT at the remote control unit is operated, transmit-receive relay K2601 is energized by grounding terminal 9 on the relay (fig. 79). Resistors R2602, R2603, and R2604 are series-dropping resistors which limit the coil current.

(1) When relay K2601 is energized, neon TRANSMIT lamp I2601 is illuminated by the application of +160 volts through closed relay contacts 1 and 12, and current-limiting resistor R2609.

(2) With switch S2602 set in the FREQ. 1 REC. 1 or the FREQ. 2 REC. 1 and 2 position, a polarizing voltage is applied to the 600-ohm line, through line transformer T2601 and closed contacts (3 and 4, and 7 and 14) on relay K2601. This polarizing voltage operates either the frequency 1 or frequency 2 relay in Radio Set Control C–844/U at the local position (fig. 78). Rectifiers CR701 and CR702, connected across the coils of relay K701 and K702, are polarized to by-pass the frequency 1 relay coil, if switch S2602 is set in the FREQ. 2 REC. 1 and 2 position. Conversely, the frequency 2 relay is by-passed if this switch is placed in the FREQ. 1 REC. 1 position.

(3) With switch S2602 in either FREQ. 1 REC. 1 or the FREQ. 2 REC. 1 and 2 position, the polarizing voltage is applied to relay K701 or relay K702 in Radio Set Control C–844/U only when receive-transmit relay K2601 at Radio Set Control C–845/U is energized by pressing the remote handset push-to-talk switch

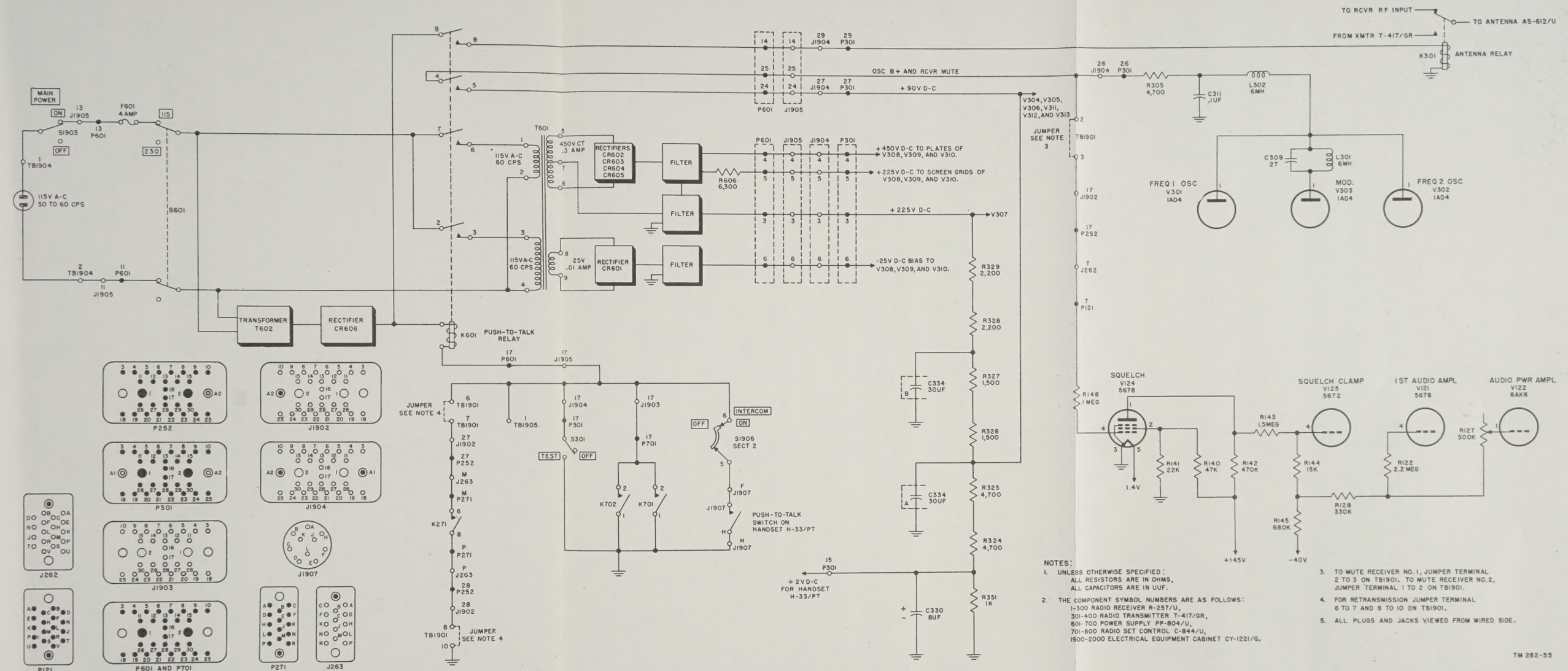


Figure 60. Push-to-talk circuits.

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS,
   ALL CAPACITORS ARE IN UUF.
2. THE COMPONENT SYMBOL NUMBERS ARE AS FOLLOWS:
   1-300 RADIO RECEIVER R-257/U,
   301-400 RADIO TRANSMITTER T-417/GR,
   601-700 POWER SUPPLY PP-804/U,
   701-800 RADIO SET CONTROL C-844/U,
   1900-2000 ELECTRICAL EQUIPMENT CABINET CY-1221/G.
3. TO MUTE RECEIVER NO. 1, JUMPER TERMINAL 2 TO 3 ON TB1901. TO MUTE RECEIVER NO. 2, JUMPER TERMINAL 1 TO 2 ON TB1901.
4. FOR RETRANSMISSION JUMPER TERMINAL 6 TO 7 AND 8 TO 10 ON TB1901.
5. ALL PLUGS AND JACKS VIEWED FROM WIRED SIDE.

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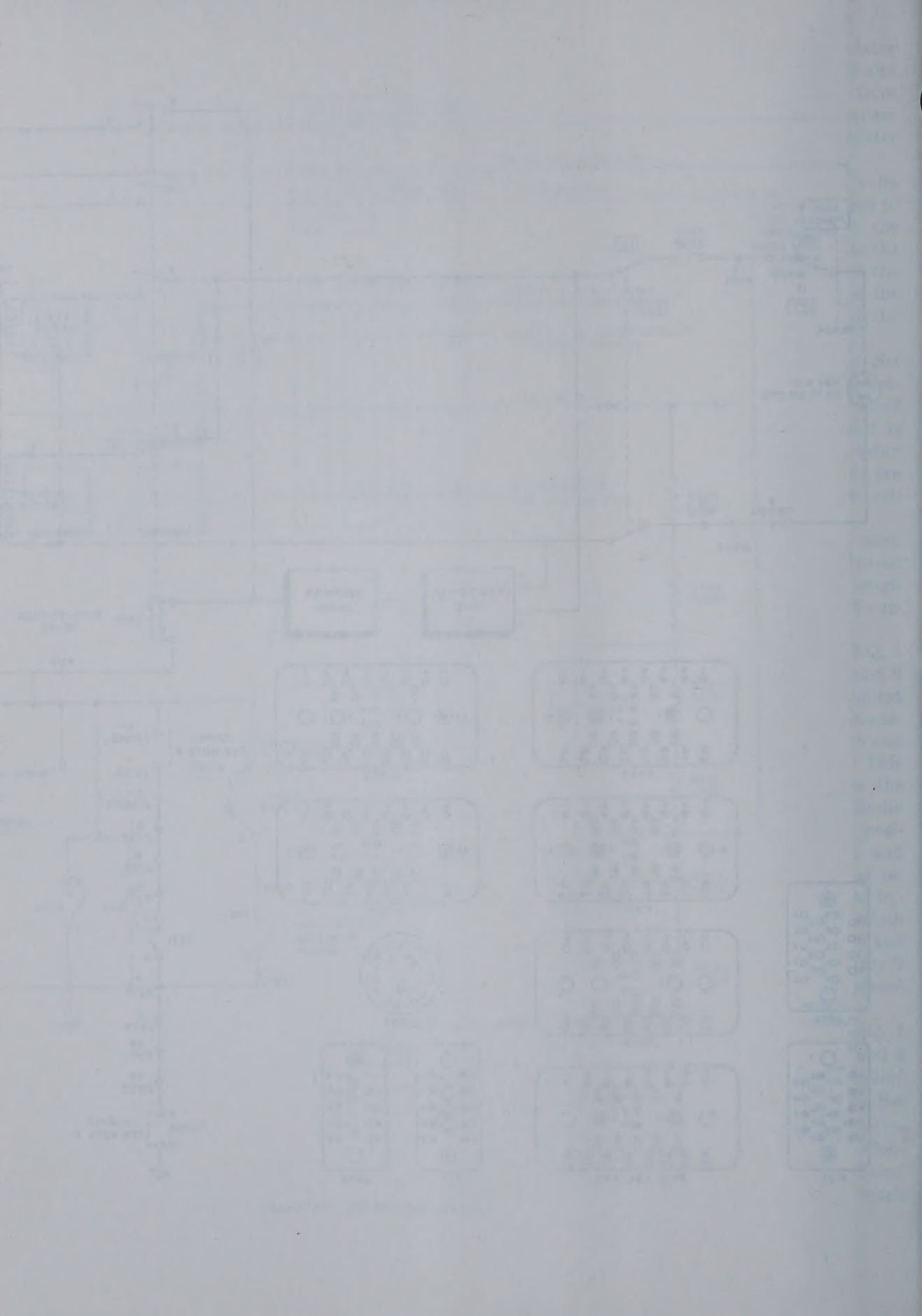


(fig. 59). Whenever either relay is operated, the push-to-talk line at terminal 17 of connector P701 is grounded, and push-to-talk relay K601 in Power Supply PP–804/U is energized (fig. 60).

Note. Relays K701 and K702 will not operate when switch S2602 is in the INTERCOM position, because no polarizing voltage is applied to the 600-ohm line. Push-to-talk operation from the remote control unit can also be accomplished by grounding terminal 5 on terminal board TB–2603 (fig. 79).

d. Push-to-Talk Operation from Electrical Equipment Cabinet CY–1221(*)/G. The push-to-talk relay in the transmitter power supply can be energized by operating the push-to-talk button on the handset, which grounds terminal F on HANDSET jack J1907. INTERCOM. ON-OFF switch S1906 must be in the OFF position (fig. 59). Grounding terminal 6 of terminal board TB1901, or terminal 1 on terminal board TB1905, will also energize push-to-talk relay K601 in the transmitter power supply.

90. Retransmission Circuit

a. Connection of Radio Set AN/FRC–15 for retransmission is described in paragraph 33 and the setting of controls is outlined in paragraph 39. Retransmission is discussed in paragraph 48. To use the system for retransmission, Receiver No. 1 must be unmuted, the audio output of Receiver No. 1 must be applied to the modulator stage of the transmitter, and additional voltages must be provided for the operation of the transmitter. The retransmission circuit used in Radio Set AN/FRC–15 is shown in the simplified schematic diagram (fig. 61).

b. For retransmission, use relay plug-in unit K271 (part of Receiver Subassembly MX–1547/G) in Radio Receiver R–257/U. When this relay is used, the jumper across terminals 10 and 9 of terminal board TB251, in the receiver, must be removed and connected across terminals 10 and 11 instead. When an audio signal is present in the receiver, action of the squelch circuit allows audio output tube V122 to conduct. Cathode current then flows through the coil of relay K271, which energizes the relay and closes contacts 8 and 6. Rectifier CR606 in Power Supply PP–804/U applies 6.5 volts to one side of the coil of push-to-talk relay K601. The other side of the coil is connected to ground through a jumper across terminals 6 and 7 of TB1901, closed contacts 6 and 8 of the squelch relay K271, and a jumper across terminals 8 and 10 of TB1901. Push-to-talk relay K601 is energized and its contacts close to provide the necessary voltages for transmission. Refer to figure 60 and paragraph 89 for a complete description of the operation of this relay and its associated B+ distribution circuits.

c. To prevent interference during retransmission, the transmission frequency must be different from the reception frequency. Also, if Receiver No. 2 is operated, its audio output must be muted (par. 31). Figure 60 shows the B+ distribution required for muting purposes.

d. The audio output of Receiver No. 1 is connected to a resistive network consisting of R706, R707, and R708 in Radio Set Control C–844/U. Resistor R708 matches the output impedance of the audio output transformer in the receiver. A part of the audio signal is dissipated across resistor R707. Terminals 2 and 3 of terminal board TB701 are connected with a wire jumper, which applies the audio signal directly to the line input attenuator AT701.

e. The line input control, an L-pad attenuator, is used to adjust the magnitude of the audio signal passed through the intercomponent connector P701 and its mating connector J1903, in Electrical Equipment Cabinet CY–1221(*)/G, which then routes the audio signal through connector J1904 to its mating connector P301, in Radio Transmitter T–417/GR. Line transformer T301 steps up the audio impedance to match the grid circuit of first audio amplifier V311 in the transmitter. Resistor R371 provides a constant load for the secondary of transformer T301. Capacitor C373 and resistor R369 are part of the pre-emphasis network of the first audio amplifier.

91. Theory of Intercom Operation
(figs. 62 and 63)

a. Intercommunication between the remote Radio Set Control C–845/U and the local Radio Set Control C–844/U is one of the operational features of Radio Set AN/FRC–15. The audio signal is transferred along a 600-ohm line between the local and remote operating positions. Intercom operation is discussed in paragraph 50*f*.

b. The microphone of Handset H–33D/PT is electrically connected to connector J2601, through terminals C and E. A dc voltage is applied to

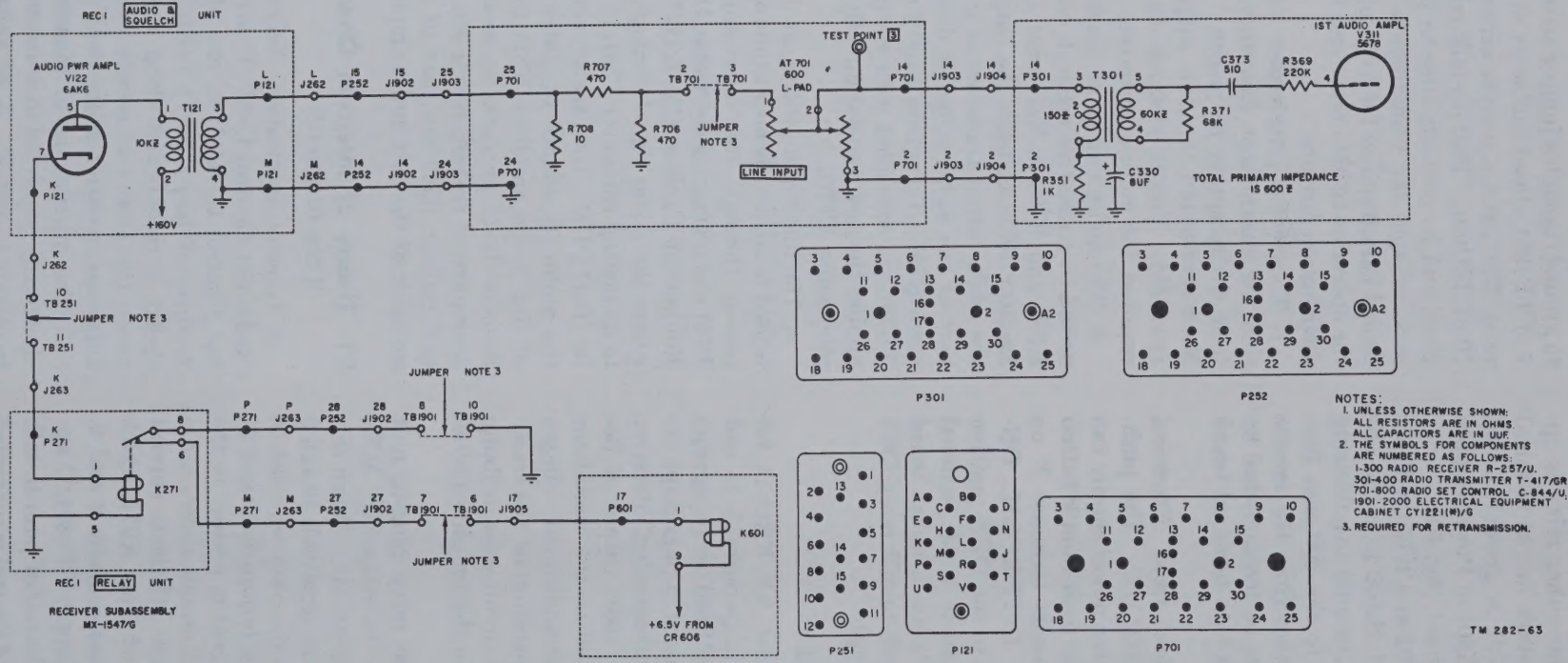
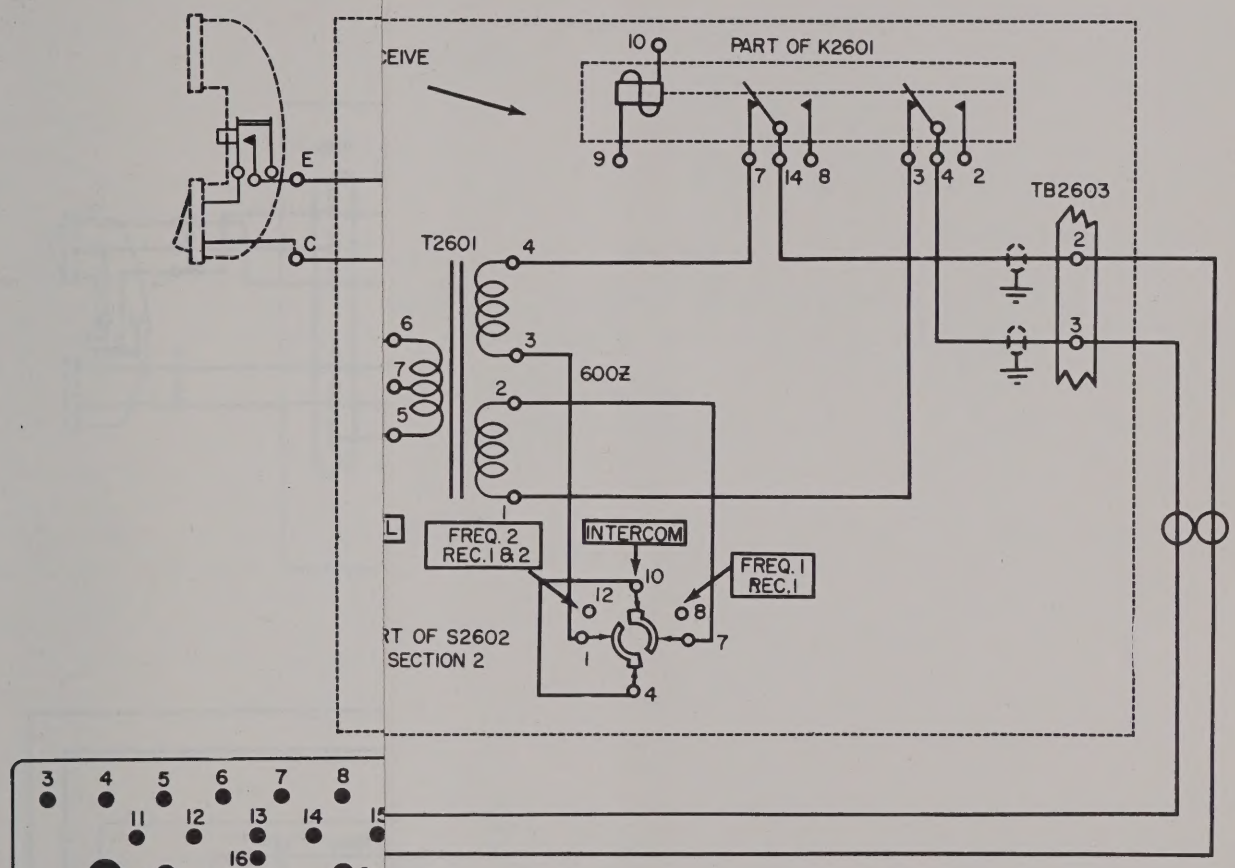
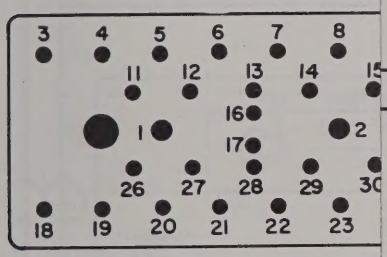
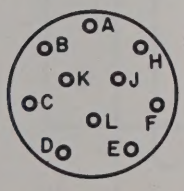


Figure 61. Retransmission circuit.



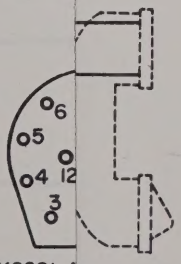


P701



SEE NOTE 5

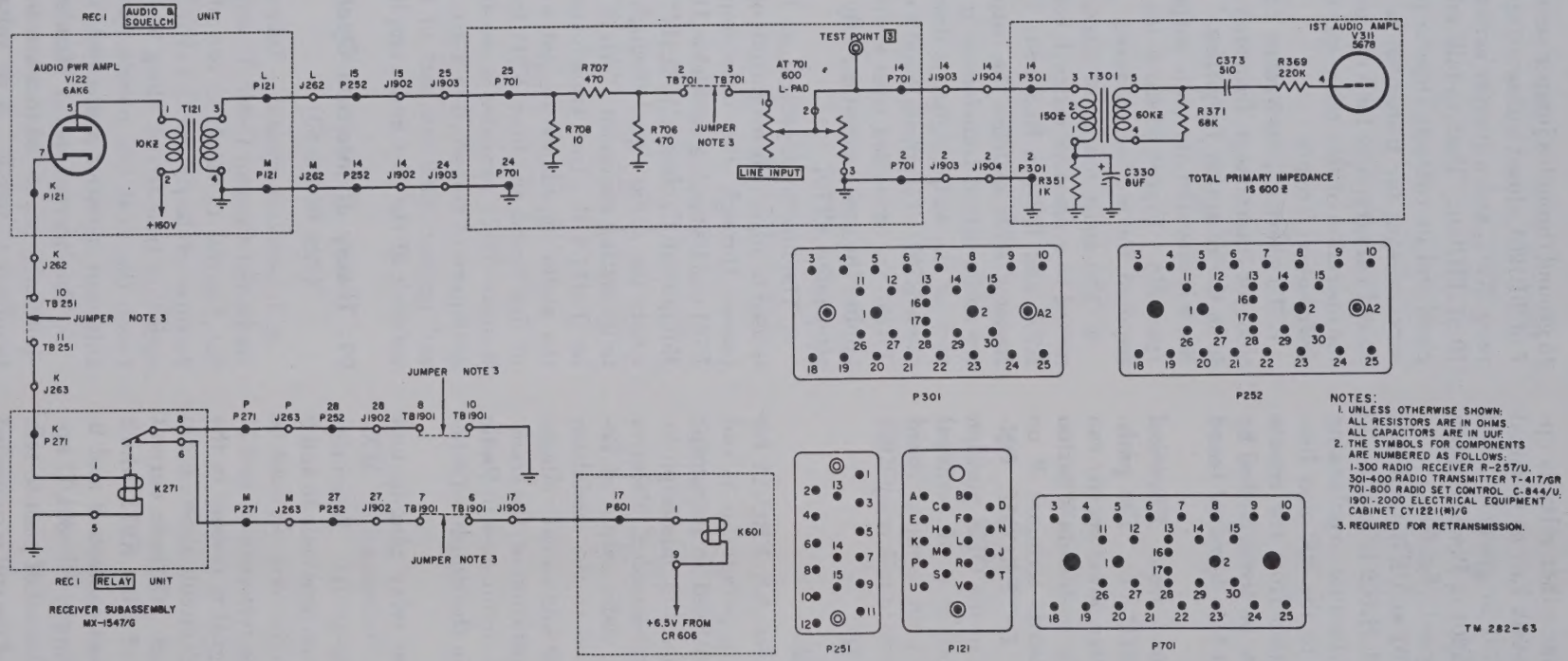
J2601 AND J1907



K2601 A

NOTES:

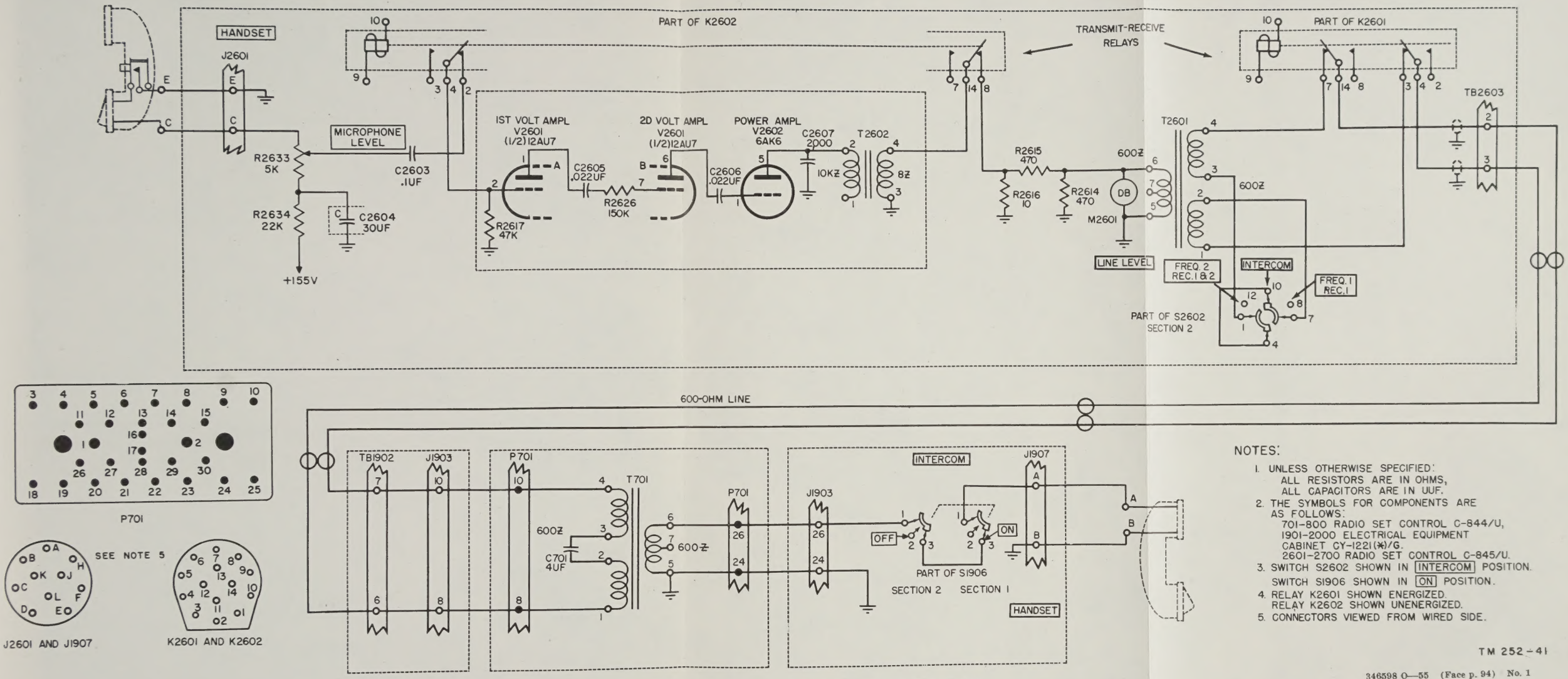
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS,
   ALL CAPACITORS ARE IN UUF.
2. THE SYMBOLS FOR COMPONENTS ARE AS FOLLOWS:
   701-800 RADIO SET CONTROL C-844/U,
   1901-2000 ELECTRICAL EQUIPMENT CABINET CY-1221(*)/G.
   2601-2700 RADIO SET CONTROL C-845/U.
3. SWITCH S2602 SHOWN IN INTERCOM POSITION.
   SWITCH S1906 SHOWN IN ON POSITION.
4. RELAY K2601 SHOWN ENERGIZED.
   RELAY K2602 SHOWN UNENERGIZED.
5. CONNECTORS VIEWED FROM WIRED SIDE.



NOTES:
1. UNLESS OTHERWISE SHOWN:
   ALL RESISTORS ARE IN OHMS
   ALL CAPACITORS ARE IN UUF
2. THE SYMBOLS FOR COMPONENTS ARE NUMBERED AS FOLLOWS:
   1-300 RADIO RECEIVER R-257/U.
   301-400 RADIO TRANSMITTER T-417/GR
   701-800 RADIO SET CONTROL C-844/U.
   1901-2000 ELECTRICAL EQUIPMENT CABINET CY1221(M)/G
3. REQUIRED FOR RETRANSMISSION.

TM 282-63

Figure 61. Retransmission circuit.

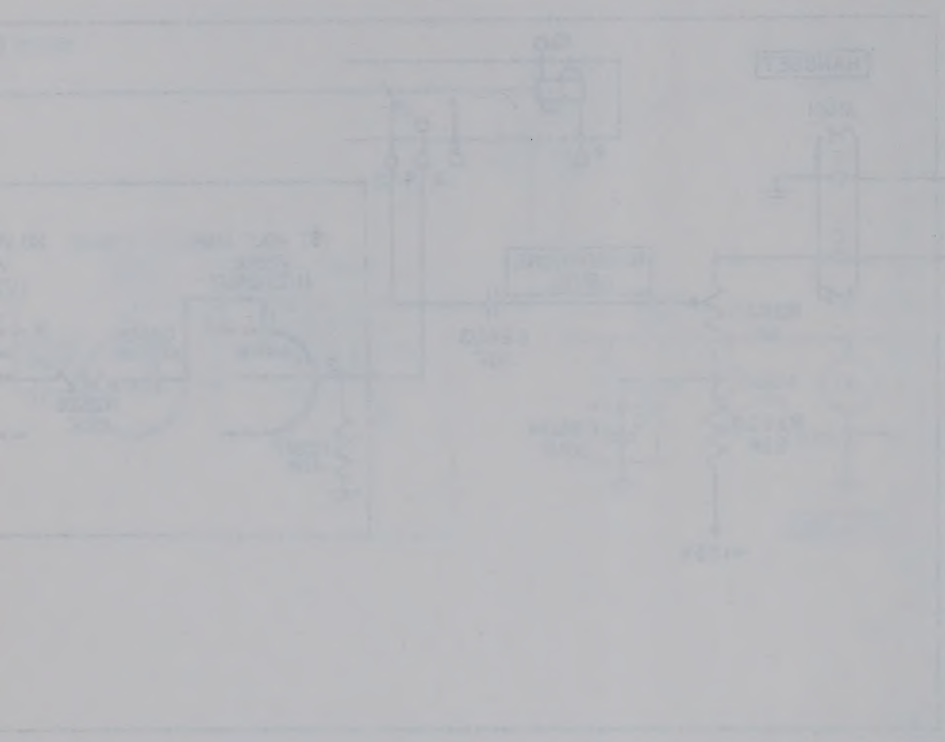


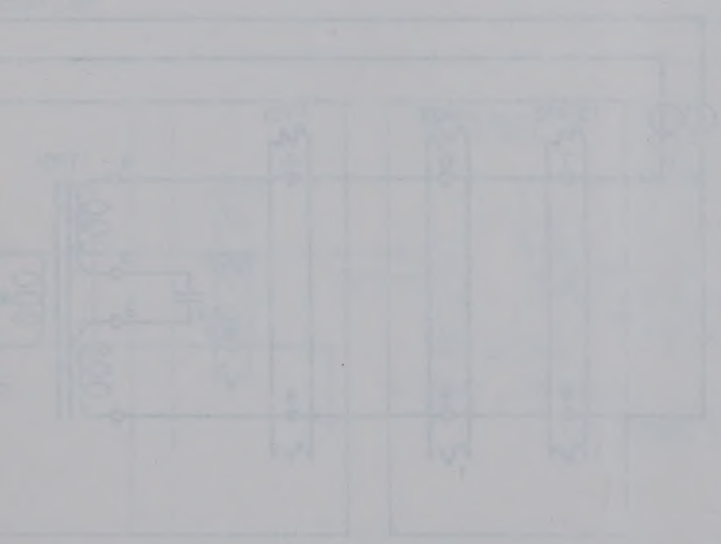
NOTES:

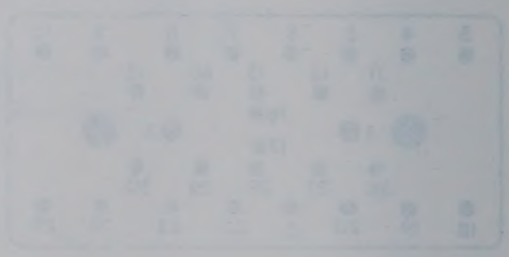
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS,
   ALL CAPACITORS ARE IN UUF.
2. THE SYMBOLS FOR COMPONENTS ARE AS FOLLOWS:
   701–800 RADIO SET CONTROL C-844/U,
   1901–2000 ELECTRICAL EQUIPMENT CABINET CY-1221(*)/G.
   2601–2700 RADIO SET CONTROL C-845/U.
3. SWITCH S2602 SHOWN IN INTERCOM POSITION.
   SWITCH S1906 SHOWN IN ON POSITION.
4. RELAY K2601 SHOWN ENERGIZED.
   RELAY K2602 SHOWN UNENERGIZED.
5. CONNECTORS VIEWED FROM WIRED SIDE.

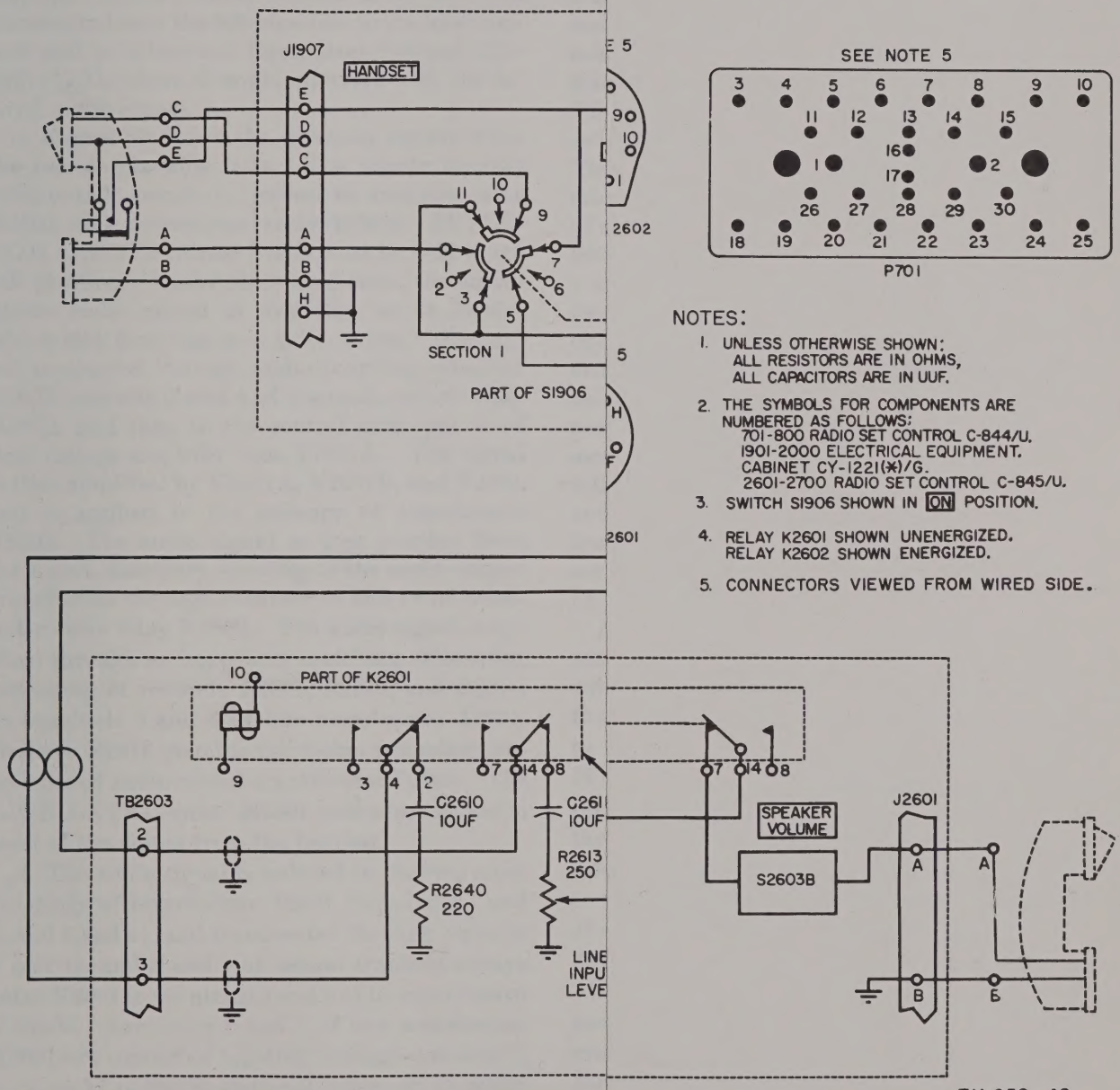
TM 252-41

Figure 62. Intercom talk circuit from remote control to local control.

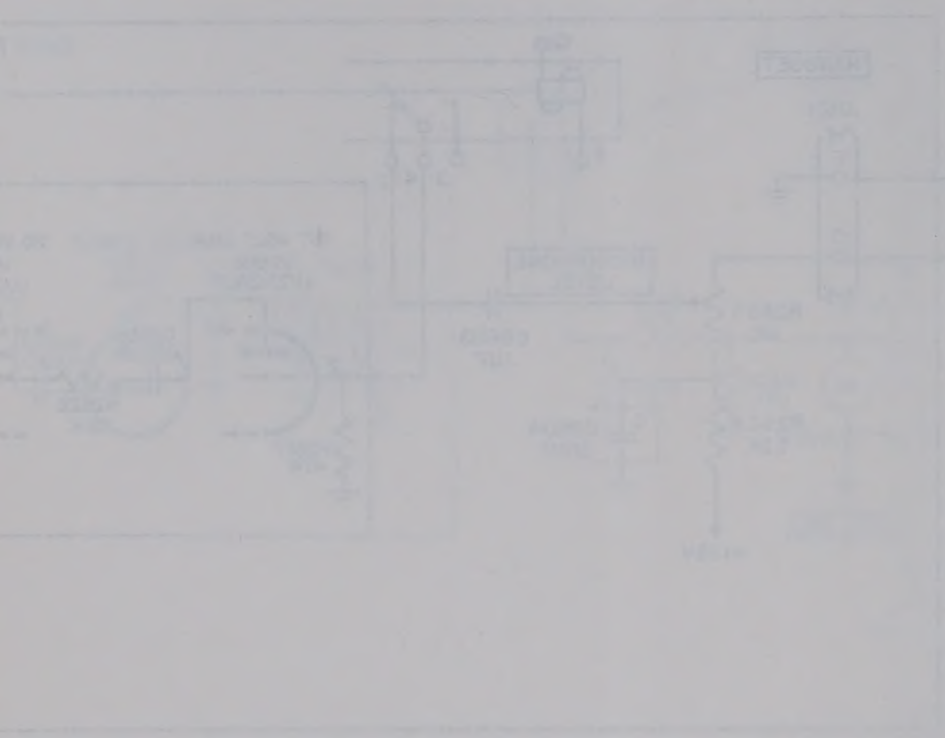


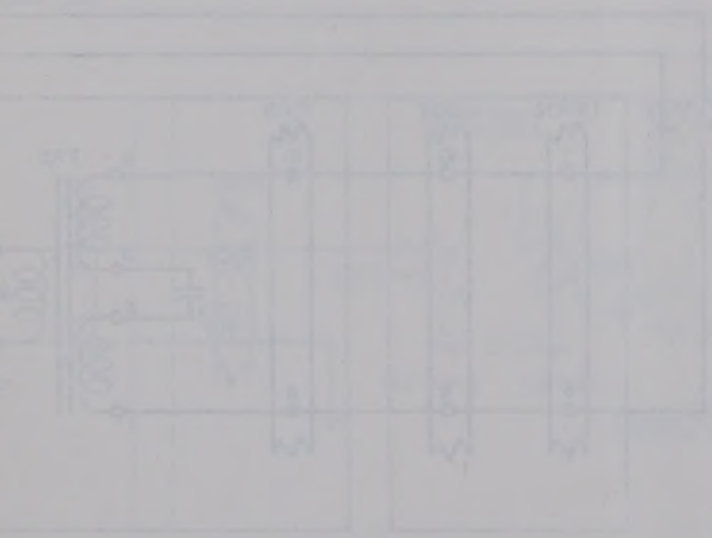





J1907
HANDSET
C
D
E
A
B
E
D
C
A
B
H
SECTION 1
PART OF S1906
2602
2601
SEE NOTE 5
P701
3 4 5 6 7 8 9 10
11 12 13 14 15
16
1
2
17
26 27 28 29 30
18 19 20 21 22 23 24 25
NOTES:
1. UNLESS OTHERWISE SHOWN:
ALL RESISTORS ARE IN OHMS,
ALL CAPACITORS ARE IN UUF.
2. THE SYMBOLS FOR COMPONENTS ARE NUMBERED AS FOLLOWS:
701-800 RADIO SET CONTROL C-844/U.
1901-2000 ELECTRICAL EQUIPMENT.
CABINET CY-1221(*)/G.
2601-2700 RADIO SET CONTROL C-845/U.
3. SWITCH S1906 SHOWN IN ON POSITION.
4. RELAY K2601 SHOWN UNENERGIZED.
RELAY K2602 SHOWN ENERGIZED.
5. CONNECTORS VIEWED FROM WIRED SIDE.
PART OF K2601
TB2603
C2610
10UF
R2640
220
R2613
250
SPEAKER
VOLUME
S2603B
J2601
A
B
LINE
INPU
LEVE

TM 252-42





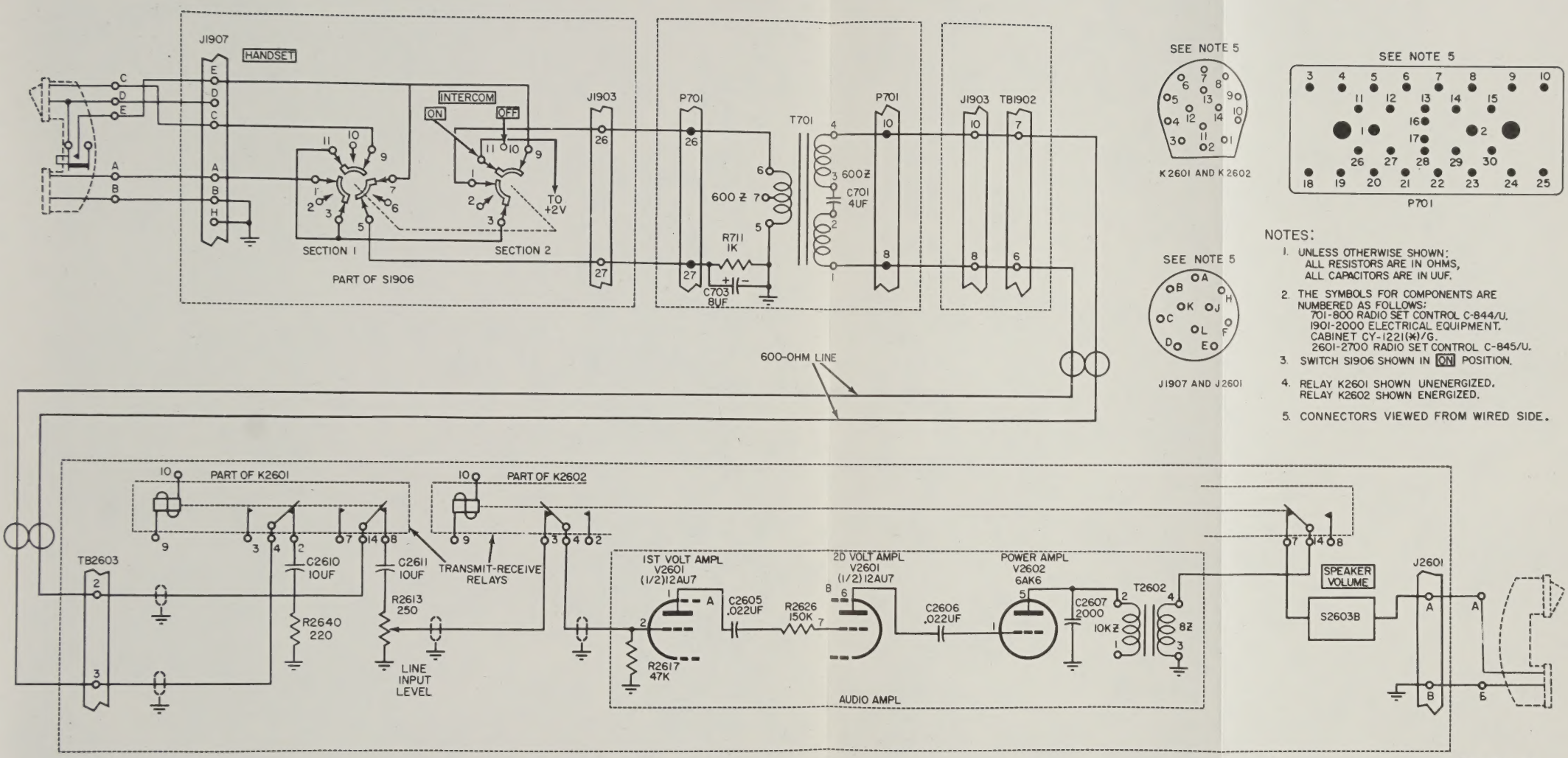
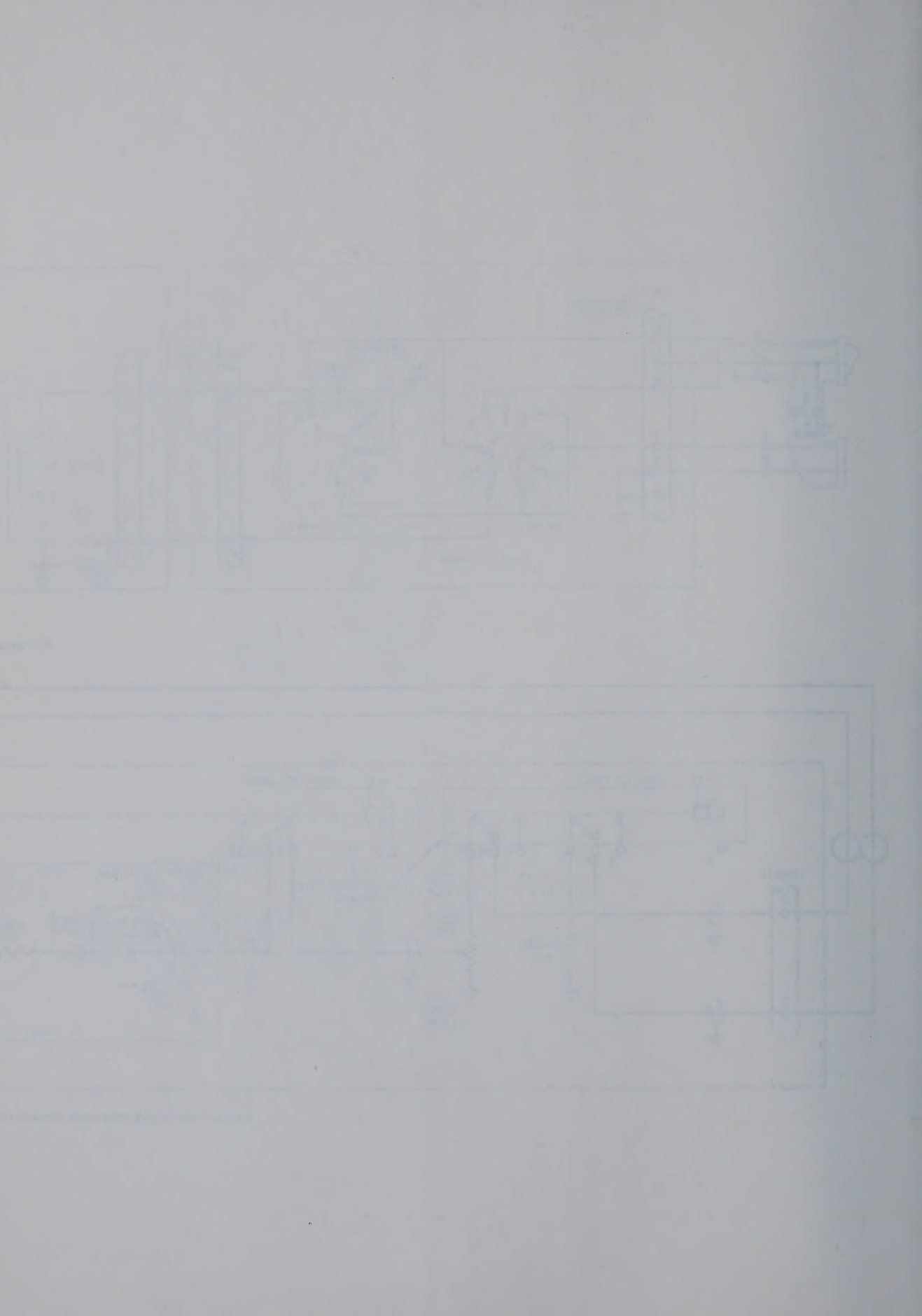


Figure 63. Intercom talk circuit from local control to remote control.



the microphone from a +155-volt source in the remote control unit power supply. This voltage is reduced to 2 volts by voltage-dropping resistor R2634 and MICROPHONE LEVEL control R2633. Filter capacitor C2604C removes and hum from the microphone voltage and provides an audio return to ground. Any hum present in the microfilm circuit would be amplified by the audio amplifier in the remote control unit, and then transmitted over the 600-ohm line to the local control unit at Electrical Equipment Cabinet CY–1221(*)/G, where it would interfere with the desired audio signal.

c. Figure 62 shows the intercom circuit when the remote operator talks. The remote handset push-to-talk switch is pressed to energize relay K2601 and de-energize relay K2602. INTERCOM. ON-OFF switch S1906 must be held to the ON position. Under these conditions, the microphone audio signal is available across R2633, which also functions as a gain control. The signal is coupled through audio coupling capacitor C2603, contacts 2 and 4 of transmit-receive relay K2602, and then to the control grid, pin 2, of first voltage amplifier tube V2601A. The signal is then amplified by V2601A, V2601B, and V2602, and is applied to the primary of transformer T2602. The audio signal is then coupled from the 8-ohm secondary winding of the audio output transformer through contacts 14 and 18 of transmit-receive relay K2602. The audio signal is applied through an impedance-matching attenuator, consisting of resistors R2614, R2615, and R2616, to terminals 5 and 6 of line transformer T2601. Resistor R2616 matches the 8-ohm secondary impedance of audio output transformer T2602. The LINE LEVEL meter M2601 indicates the audio level of the signal from the handset.

d. The audio signal is induced in the two other windings of transformer T2601 (terminals 1 and 2, and 3 and 4), and is connected through contacts 7 and 14, and 3 and 4 of second transmit-receive relay K2601 to terminals 2 and 3 of terminal board TB2603. Terminals 2 and 3 of line transformer T2601 are connected together through contacts 1, 4, 10, and 7 of S2602, section 2, when switch S2602 is set in the INTERCOM position. The audio signal is transmitted over the 600-ohm line to terminals 6 and 7 on terminal board TB1902 at Electrical Equipment Cabinet CY–1221(*)/G. These terminals are connected to terminals 8 and 10 of mating connectors J1903 and P701, and then to terminals 1 and 4 of line transformer T701. Capacitor C701 connects terminals 2 and 3 of transformer T701 together for af, because of its very low reactance at audio frequencies, but appears as an open circuit for the dc polarizing voltage used for frequency selection. The audio signal is developed across terminals 5 and 6 of transformer T701, and passed to terminals 24 and 26 of mating connectors P701 and J1903. One side of the audio line is grounded, and the other side is connected to terminal 1, section 2, of INTERCOM. ON-OFF switch S1906. In figure 62, switch S1906 is shown held in the ON position. The signal continues through the switch to terminals 3 of section 2 and section 1. Terminal 1 of section 1 is connected to terminal A of HANDSET connector J1907.

e. Figure 63 shows how the operator at the local Radio Set Control C–844/U can talk to the operator at the remote Radio Set Control C–845/U. The operator at the local position can be heard at the remote control unit only when the push-to-talk button, on the handset, at the remote control is released. Releasing the push-to-talk button allows relay K2601 to de-energize, and relay K2602 to energize, thus reversing the line amplifier connections so that the signal that arrives at the remote control unit is amplified (figs. 62 and 63).

f. Handset H–33D/PT, at the local position, connects to connector J1907 (fig. 63). Plus 2 volts is connected through contacts 11 and 9, section 2 of INTERCOM ON-OFF switch (S1906) to terminal E of connector J1907 and Handset H–33D/PT. When the push-to-talk switch is operated, current from the +2-volt source flows through the handset push-to-talk switch to one side of the microphone, through the microphone to terminal C of J1907, through sections 1 and 2 of switch S1906, to terminal 26 of connector J1903. Terminals E on the handset, and on connector J1907 are connected through terminals 7 and 5, section 1, switch S1906, to terminal 27 of intercomponent connectors J1903 and P701, to ground, through resistor R711. Resistor R711 is part of a voltage dividing network which reduces a +160 volts to approximately +2 volts, for operation of the handset microphone. Capacitor C703 removes any ac hum which might modulate the audio signal.

g. The audio signal is applied across terminals 5 and 6 of line transformer T701, and then induced in the 2d and 3d windings of the transformer. These windings are series-connected through capacitor C701, which appears as a very low reactance to audio signals, and also presents an open circuit for the dc polarizing voltage, used to select the transmitter frequency. The audio signal continues from terminals 1 and 4 of transformer T701 to terminals 8 and 10 of the mating intercomponent connectors P701 and J1903, to terminals 6 and 7 of terminal board TB1902, to the 600-ohm line which connects to terminal board TB2603 in the remote control unit, Radio Set Control C–845/U.

h. The audio signal is routed through contacts 4 and 2, and 14 and 8 of transmit-receive relay K2601. Each leg of the 600-ohm line returns to ground through a resistor and a blocking capacitor (R2640 and C2610, and R2613 and C2611) so that the two resistances are effectively connected in series across the 600-ohm line. A portion of the audio signal is selected by line input level control R2613 and then connected through contacts 3 and 4 of transmit-receive relay K2602 to the control grid (pin 2) of first voltage amplifier tube V2601A. The theory of operation of the audio amplifier is discussed in paragraph 78.

i. Audio output from the amplifier is obtained at terminals 4 and 3 (ground) of audio output transformer T2602. The audio signal at terminal 4 is connected through contacts 14 and 7 of relay K2602, through SPEAKER VOLUME control switch S2603B, to the earpiece of the remote handset, through terminal A of connector J2601. The other terminal of the earpiece connects to ground through terminal B of connector J2601.

j. The operator at the remote position (Radio Set Control C–845/U) can talk to the local operator only when the local operator holds the INTERCOM ON-OFF switch to the ON position (par. 50*f*). The operator at the local position can signal or call the operator at the remote position whenever the push-to-talk button of the remote handset is not operated. This means that remote control unit relays K2601 and K2602 must be in their *receive* positions (K2601 de-energized, K2602 energized).

CHAPTER 6

FIELD MAINTENANCE

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibilities is limited only by the tools and test equipment available and by the skill of the repairman.

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

Warning: There are certain points in the radio set that operate at voltages in excess of 450 volts; therefore, when servicing Radio Set AN/FRC–15, be extremely careful of exposure to these and other high voltage points. Be sure that all power is turned off before touching any of the connections. Read the caution notices on the components and their respective manuals before attempting repairs.

92. General

This chapter contains general field maintenance procedures for system troubleshooting and detailed field maintenance instructions for Radio Set Control C–845/U, Radio Set Control C–844/U, and Electrical Equipment Cabinet CY–1221(*)/G. Consult the following publications for detailed information related to the maintenance of the other radio set components:

Component	Publication
Radio Transmitter T–417/GR	TM 11–804
Radio Receiver R–257/U	TM 11–5071
Power Supply PP–804/U	TM 11–5072
Power Supply PP–846/U	TM 11–5078

93. Troubleshooting Procedure

The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to the major component or circuit responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal conditions. Some faults such as burned out resistors, rf arcing, and shorted transformers, can be located by sight, smell, and hearing. The majority of faults, however, must be localized by checking voltages and resistances.

a. System Sectionalization. Radio Set AN/FRC–15 should be set up for operation by following instructions given in paragraphs 35 through 38. Check the operation of each component against the equipment performance check list for any abnormal indication. This often will indicate the unit at fault. Once the trouble is found to be in a certain unit, it then can be localized.

b. Localization. Localization of a trouble within a component of Radio Set AN/FRC–15 may be accomplished by following the instructions in the individual manuals, except for Radio Set Control C–844/U and Radio Set Control C–845/U, which are covered in this manual.

94. Troubleshooting Data

Take advantage of the material supplied in this manual. It will help in the rapid sectionalization of faults. Diagrams showing the key circuits of the system such as interunit connections, simplified control circuits, rf distribution, and schematic diagrams of each unit, are provided in addition to those which will be found in the individual manuals. By tracing the key circuits through switches, terminal boards, and cables, the trouble usually can be found rapidly. During the troubleshooting procedures, it may be helpful to refer to paragraphs 70 through 88 for theory of operation. This will enable the repairman to locate

the trouble more rapidly and possibly prevent unnecessary work. Consult troubleshooting data in other manuals furnished and also the following data in this manual.

Fig. No.	Description
9	Radio Set Control C–844/U.
29	Radio Transmitter T–417/GR, alinement points.
30	Radio Receiver R–257/U, compartment location.
32	Radio Receiver R–257/U, local oscillator and rf amplifier alinement points.
38	Radio Receiver R–257/U, front panel test points.
64	Electrical Equipment Cabinet CY–1221(*)/G, with rear cover removed.
65	Radio Set Control C–844/U, top view of chassis.
66	Radio Set Control C–844/U, bottom view of chassis.
67	Radio Set Control C–845/U, top view of chassis.
68	Radio Set Control C–845/U, bottom view of chassis.
69	Radio Set Control C–845/U, rear view of chassis.
70	Radio Set Control C–844/U, resistance diagram.
71	Radio Set Control C–845/U, voltage and resistance diagram.
72	Radio Set Control C–845/U, internal adjustment location.
73	Radio Set Control C–845/U, set up for output adjustment.
74	Radio Set Control C–845/U, set up for input adjustment.
77	Handset H–33D/PT, schematic diagram.
79	Radio Set Control C–845/U, overall schematic diagram.
80	Power Supply PP–846/U, overall schematic diagram.
81	Power Supply PP–804/U, overall schematic diagram.
82	Electrical Equipment Cabinet CY–1221(*)/G, overall schematic diagram.
83	Radio Transmitter T–417/GR, overall schematic diagram.
84	Radio Receiver R–257/U, overall schematic diagram.

95. Test Equipment Required for Troubleshooting

The test equipment required for troubleshooting Radio Set AN/FRC–15 is listed below. The technical manuals associated with the test equipment are also listed.

Test Equipment	Common name	Technical manual
Multimeter TS–352/U or equal.	Multimeter	TM 11–5527
Electrical Multimeter TS–505/U.	Vacuum tube voltmeter.	TM 11–551I
Electron Tube Test Set TV–7/U.	Tube tester	TM 11–5083

96. General Precautions

Whenever the individual components of Radio Set AN/FRC–15 are serviced, observe the following precautions very carefully:

a. Be careful of the dangerous voltages exposed in Power Supply PP–804/U when covers are off.

b. Careless replacement of parts often causes new faults. Note the following points:

(1) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer or filter, has a number of connections, tag each lead.

(2) Be careful not to damage other leads by pulling or pushing them out of the way.

(3) Do not allow drops of solder to fall into the set. They may cause short circuits.

(4) A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, since a poorly soldered joint is one of the most difficult faults to locate.

(5) When a part is replaced in rf or if. circuits, it must be placed exactly as the original one. A part which has the same electrical value but different physical size may cause trouble in vhf circuits. Give particular attention to proper grounding when replacing parts. Use the same ground used in the original wiring. Failure to observe these precautions may result in decreased gain, or possibly in oscillation.

c. Arc-overs in selenium rectifiers cause the release of poisonous fumes and the deposit of poisonous selenium compounds. If arc-overs occur, avoid inhaling the poisonous fumes (they have a putrid odor, similar to rotten cabbage). Ventilate the unit. Do not handle the damaged rectifier until it has cooled. Do not touch the damaged part with bare hands.

97. Checking B+ Circuits for Shorts

Trouble within one of the units may often be detected by checking the resistance of the high voltage (hv) circuits before applying power to the equipment, thereby preventing further damage to the power supply. Refer to the complete schematic diagram for each component of the radio set. Check the set for low resistance readings or short circuits to ground at all points along

the hv distribution path. Pay particular attention to the condition of capacitors. Leaky or low resistance capacitors will draw excessive current from the rectifier systems. If a short, or a near short, is detected by an ohmmeter reading, the defective part usually is a shorted or leaky filter capacitor or an rf by-pass capacitor. A suspected defective capacitor must be disconnected at one end to check its resistance. Another possible cause of a short or near short is an internally shorted tube. Where this condition is suspected, remove the tube from its socket while checking components. If removal of the tube restores the circuit resistance to normal, the tube is defective.

98. Operational Test

For a complete check of all components, Radio Set AN/FRC–15 should be connected for remote operation as instructed in paragraph 32. Operate the system in accordance with each step of the equipment performance checklist (par. 69). This checklist is important because frequently it indicates the general location of trouble. Listen for crackling or buzzing noises which indicate hv arcing. Check components for smoke and the odor of burned or overheated parts. If the normal indications described in the checklist are obtained, the radio set may be considered to be in a normal operating condition.

Section II. SYSTEM TROUBLESHOOTING

99. General

Troubleshooting Radio Set AN/FRC–15 can be performed more efficiently if the trouble is sectionalized to the defective component. The equipment performance checklist in paragraph 69 will be of much assistance in this respect. Refer to the block diagrams and schematic diagrams of the radio set for additional information to aid in sectionalizing trouble. After tracing the trouble to one component, the trouble must be localized to the defective part. The components in the radio set have their own manuals. Refer to them if the trouble is sectionalized to one component. Detailed information on the components which do not have separate manuals is given in this manual.

100. Troubleshooting Chart for Radio Set AN/FRC–15

Symptom	Probable trouble	Correction
The pilot light on CY–1221(*)/G does not light when the MAIN POWER switch is closed.	Receiver power supply fuse F3001	Turn on the squelch control for Receiver No. 1 to OFF. If a rushing noise is heard in handset, check pilot light and resistor R1902. If noise is not heard, check F3001 and S1903.
	MAIN POWER switch S1903	Same as above.
	Pilot light or resistor R1902	Replace defective parts.
No output from either or both receivers at the local position.	Handset	Substitute handset.
	Antenna, jumper, and transmission line connections.	Check connections for local operation (par. 31).
	Receivers	Refer to TM 11–5071.
	Receiver power supplies	Refer to TM 11–5078.
No output from either or both receivers at the remote position.	Radio Set Control C–844/U	Refer to paragraph 102.
	Radio Set Control C–845/U	Refer to paragraph 103.
	600-ohm line	Check line for open or short circuit.
	Power supply in Radio Set Control C–845/U.	Refer to TM 11–5078.
	Connections	Check connections for remote operation (par. 32).
Receiver will not squelch	Squelch control in OFF position	Turn control.
	Defective squelch control	Replace.
	Receiver audio and squelch plug-in unit.	Refer to TM 11–5071.

Symptom	Probable trouble	Correction
Transmitter will not key from either local or remote position.	In transmitter	Check for correct readings at panel jacks. Refer to TM 11–804 for detailed information.
	Power Supply PP–804/U	Check cable connections. Refer to TM 11–5072 for detailed information.
Transmitter will not key from local position.	Defective handset	Replace.
	INTERCOM. ON-OFF switch (S1906).	Repair or replace.
Transmitter will not key from remote position on any position of frequency selector-intercom switch.	Radio Set Control C–845/U	Refer to paragraph 103.
	Radio Set Control C–844/U	Refer to paragraph 102.
Transmitter will not key from remote position on FREQ. 1 position.	Radio Set Control C–844/U	Refer to paragraph 102.
Transmitter will not key from the remote position on FREQ. 2 position.	Radio Set Control C–844/U	Refer to paragraph 102.
Transmitter can be keyed but not modulated from local or remote positions.	In transmitter	Refer to TM 11–804.
Transmitter can be keyed but not modulated from local position.	Handset	Check by substitution.
	Radio Set Control C–844/U	Refer to paragraph 102.
Transmitter can be keyed but not modulated from the remote position.	Handset at the remote position	Check by substitution.
	Radio Set Control C–844/U	Refer to paragraph 102.
	Radio Set Control C–845/U	Refer to paragraph 103.
Unable to change frequency at the local position.	Jumper connection	Refer to paragraph 31.
	TRANSMITTER FREQ. 1–FREQ. 2 switch (S1902).	Replace.
Unable to change frequency at the remote position.	Jumper connections	Refer to paragraph 32.
	Radio Set Control C–844/U	Refer to paragraph 102.
	Radio Set Control C–845/U	Refer to paragraph 103.
Weak reception and transmission	Stations too far apart	Refer to paragraph 27.
	Receiver out of alinement	Refer to TM 11–5071.
	Transmitter out of alinement	Refer to TM 11–804.
	Incorrect antenna length	Refer to paragraph 29.
	Wrong plate coil or antenna filter jumpers in transmitter.	Refer to paragraph 37.
Retransmission not possible	Jumper connections	Refer to paragraph 33.
	Second antenna used for Receiver No. 1.	Repair.
	Receiver relay plug-in unit (Receiver Subassembly MX–1547/G).	Refer to paragraph 33.
	Radio Set Control C–844/U	Refer to paragraph 102.
Unable to select correct transmitter frequency from the remote position.	Reversed connections on 600-ohm line.	Reverse 600-ohm line connections.

Section III. COMPONENT TROUBLESHOOTING

101. Electrical Equipment Cabinet CY–1221(*)/G Troubleshooting

(fig. 64)

a. This cabinet consists of numerous plugs, jacks, and terminal boards. When trouble is sectionalized to this component it will probably be a poor plug or jack connection, an improper terminal board connection, or broken or crossed wires. Several of the parts can be inspected visually or tested with an ohmmeter, such as the squelch controls, the INTERCOM. ON-OFF switch S1906, and the ac power switches.

Note. Be sure that ac power is disconnected from the radio set before attempting any tests on the cabinet.

b. When testing the connectors, terminal boards, and the cabinet wiring, a visual inspection of the

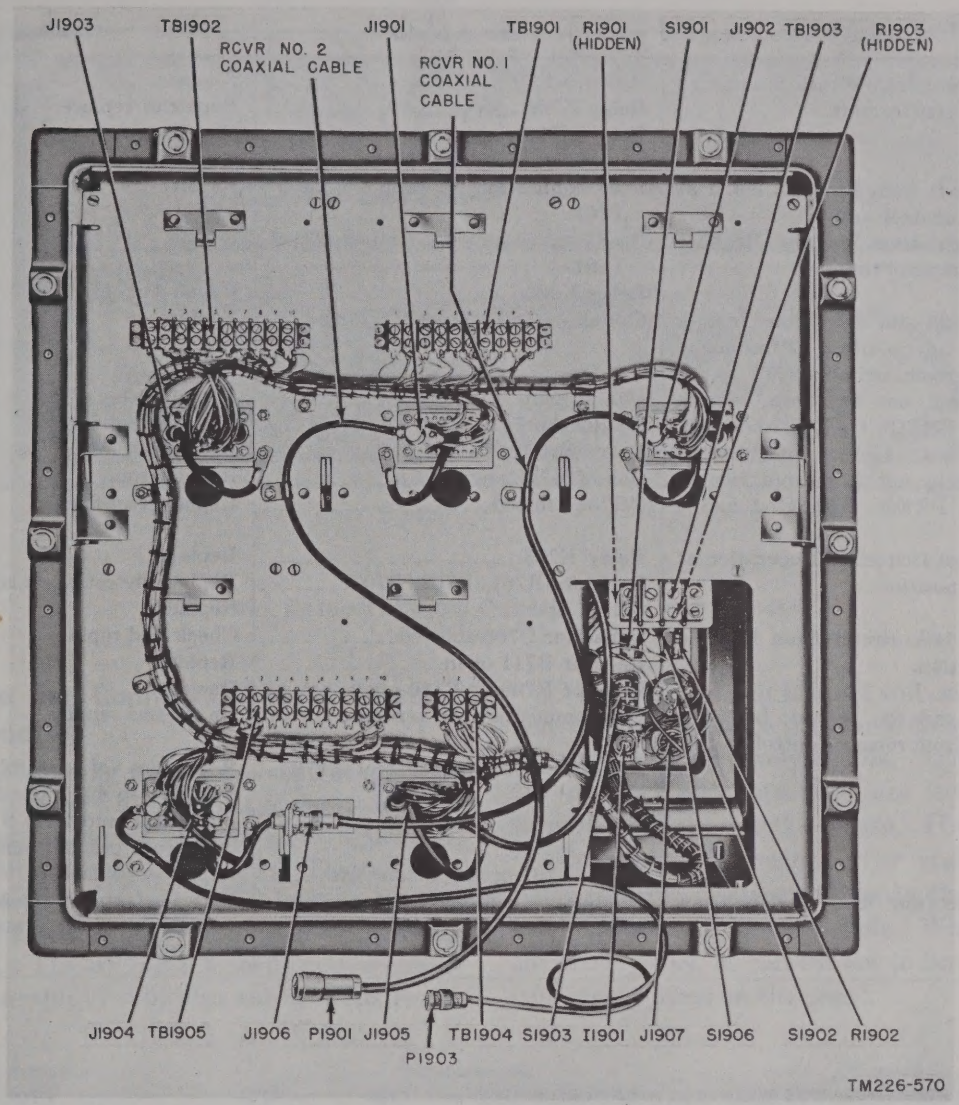


Figure 64. Electrical Equipment Cabinet CY–1221/G, with rear cover removed.

questionable items will be very useful. A continuity check from point to point, and point to ground, by two repairmen with the aid of Electrical Equipment Cabinet CY–1221(*)/G overall schematic diagram (fig. 82) will detect any broken or otherwise defective wiring. A study of the probable trouble from the information contained in this manual will eliminate many needless continuity tests, and will result in a quick and successful location of the defective circuit.

c. When attempting continuity tests of this cabinet, exercise care so that wires and connections at the intercomponent connectors will not become needlessly frayed, crossed, or severed. If it is necessary to replace one of these connectors, tag and label each wire as it is removed from the defective connector, so that later it can be connected to the correct terminal on the replacement connector.

102. Troubleshooting Chart for Radio Set C–844/U

After determining that trouble exists in Radio Set Control C–844/U, remove the unit from Electrical Equipment Cabinet CY–1221(*)/G. Refer to the radio set troubleshooting chart below. Use the resistance data in figure 70, and locate the defective part or parts in figure 65 or 66. Inspect the wiring carefully; if it is necessary to unsolder and resolder any connections, perform this task in a manner which will not cause additional circuit failures.

Symptom	Probable trouble	Correction
No audio output from either receiver at the remote control unit.	Resistor R707	Replace.
	Relay K701	Repair or replace.
	Relay K702	Repair or replace.
	T701 open	Replace.
No audio output from Receiver No. 1 at the remote control unit.	Poor connection at terminal 25 of P701.	Repair.
No audio output from Receiver No. 2 at the remote control unit.	Poor connection at terminal 23 of P701.	Repair.
	Relay K703	Repair or replace.
Transmitter will not key from remote position on any position of frequency selector-intercom switch S2602.	Capacitor C701 shorted	Replace.
Transmitter will not key from remote position on FREQ 1 REC. 1 position.	Coil of relay K701 open	Replace relay.
	CR702 shorted	Replace rectifier.
	Relay K703	Repair or replace.
Transmitter will not key from remote position on FREQ 2 REC. 1 and 2 position.	Coil of K702 open	Replace relay.
	CR701 shorted	Replace rectifier.
Unable to select frequency 1 operation at the remote position.	Relay K703	Replace.
	Resistors R701, R702, R703	Replace defective resistor.
	CR701 open	Replace.
No intercom talk circuit from local to remote position.	Capacitor C703 shorted	Check and replace.
	Resistor R711 open	Replace.
	Resistor R709 or R710 open	Replace.
Transmitter can be keyed but not modulated from remote control unit.	Poor connection at terminal 14 of P701.	Check and repair.
	Defective line input control AT701	Resistance of control should vary from 0 to 600 ohms between points 1 and 2, and from 0 to 3,000 ohms between points 3 and 2.
	Relay K701 or K702 defective	Repair or replace.
Retransmission from Receiver No. 1 not possible.	Jumper connection	Place a jumper from 2 to 3 on TB701; remove jumper from 1 to 2 on TB701.

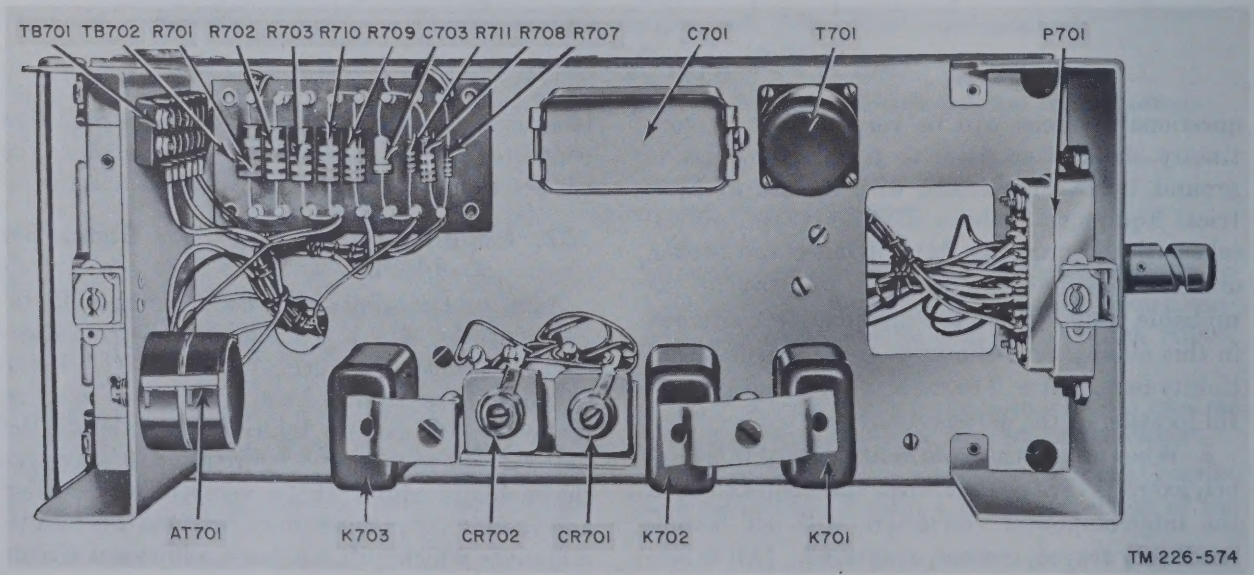


Figure 65. Radio Set Control C–844/U, top view of chassis.

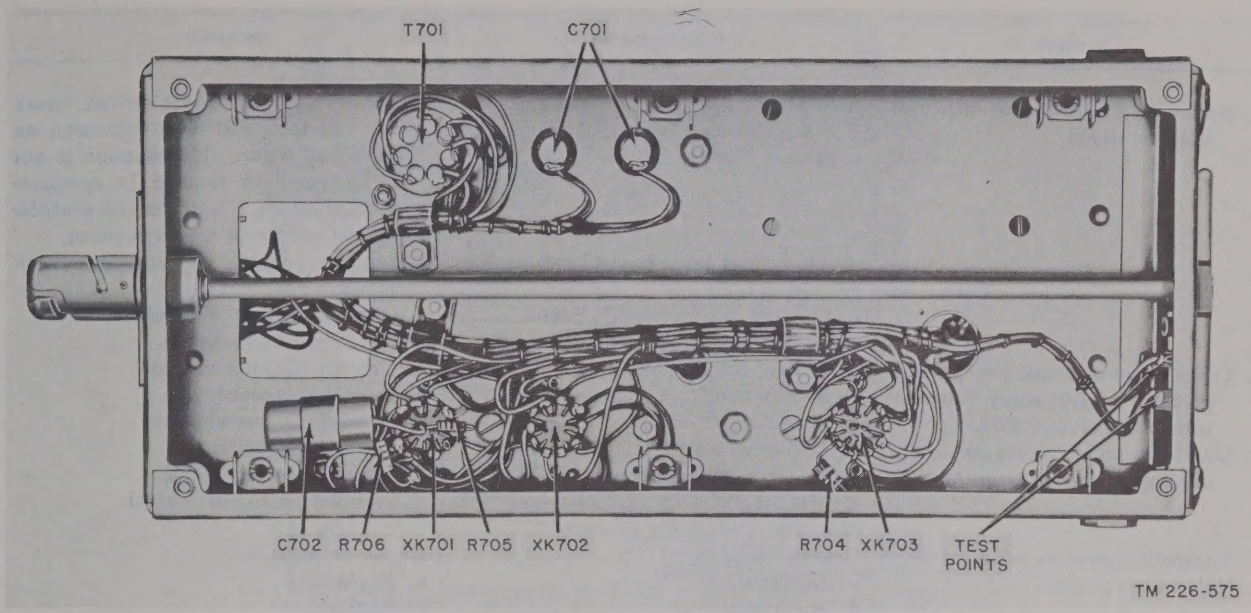


Figure 66. Radio Set Control C–844/U, bottom view of chassis.

103. Radio Set Control C–845/U Troubleshooting

a. Troubleshooting the remote control unit can be done with the aid of the voltage and resistance measurements in figure 71. Refer to figures 67, 68, and 69 for the location of parts. The radio set troubleshooting chart below will help to localize the trouble. Observe the symptoms accompanying the trouble. The equipment performance checklist in paragraph 69 will also aid the repairman.

b. This control unit is small and easily handled; consequently it can be positioned to make the testing procedure relatively simple. The majority of the resistors and capacitors are located on two terminal strips under the chassis. If any difficulty is experienced in removing or replacing front panel controls, or associated parts, the front panel can be removed from the chassis. When removing the front panel, be careful not to break the wires connecting parts on the panel.

Symptom	Probable trouble	Correction
1. POWER indicator lamp does not light when SPEAKER VOLUME switch is turned on.	*a.* Power Supply PP–846/U	*a.* Refer to TM 11–5078.
	b. Switch S2603A	*b.* Check by substitution.
	c. Pilot lamp I 2602	*c.* Check by substitution.
	d. Resistor R2635	*d.* Check resistance value.
2. No audio note when TONE switch is pressed. POWER indicator lamp lights.	*a.* Tone level control set too low	*a.* Increase setting.
	b. Switch S2601	*b.* Check continuity across closed contacts of both sections.
	c. Tone oscillator circuit	*c.* Check components.
	d. Neon tube V2603	*d.* Replace.
3. TRANSMIT indicator lamp I 2601 does not light when push-to-talk button on handset is pressed.	*a.* Pilot lamp I 2601	*a.* Check by substitution.
	b. Defective handset	*b.* Check by substitution.
	c. Relay K2601 defective	*c.* Check for open coil, sticking or pitted contacts. Replace if defective.
	d. Resistors R2602, R2603, R2604, R2609 open.	*d.* Check resistance values.

Symptom	Probable trouble	Correction
4. No audio output from either or both receivers.	*a.* V2601, V2602	*a, b, c.* Press push-to-talk switch, speak into handset, and note deflection on line level meter. If deflection is not noted, refer to item 6 in *symptom* column, and *a*, *b*, and *c* in the *probable trouble* column of that symptom.
	b. Amplifier circuit components	
	c. Relays K2601, K2602	
	d. Line input level control set too low or is open.	*d.* Increase control setting or check resistance.
	e. Speaker volume switch S2603	*e.* Check switch on all positions.
	f. R2640	*f.* Check resistance value.
5. Transmitter will not key on any position of frequency selector-intercom switch S2602.	*a.* R2605, R2607 open	*a.* Check resistance values.
	b. Switch S2602	*b.* Repair or replace.
	c. Transformer T2601	*c.* Check for open winding.
6. Line level meter indicates no audio output during transmission.	*a.* Defective meter M2601	*a.* Check by substitution.
	b. Resistor R2615 open	*b.* Check resistance value.
	c. MICROPHONE LEVEL set too low.	*c.* Increase setting of control.
7. Intercom operation not possible	Switch S2602	Repair or replace.
8. No speaker output	*a.* Switch S2604	*a.* Replace.
	b. Speaker	*b.* Replace.

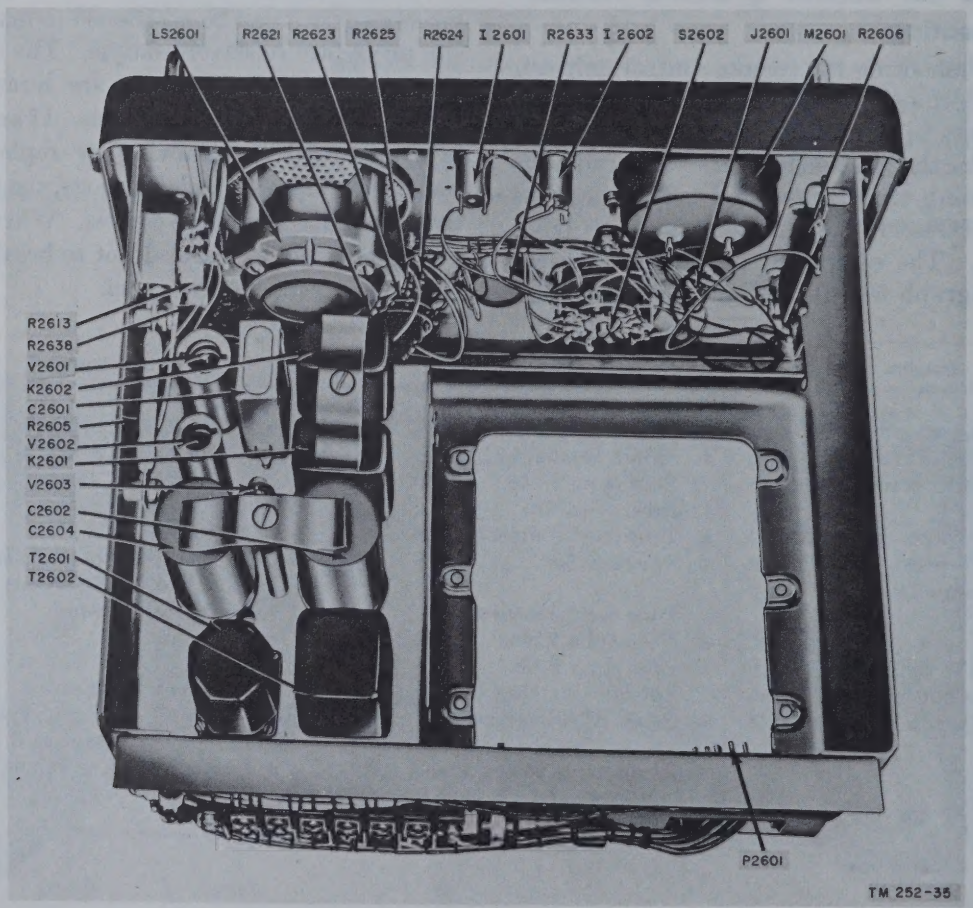


Figure 67. Radio Set Control C–845/U, top view of chassis.

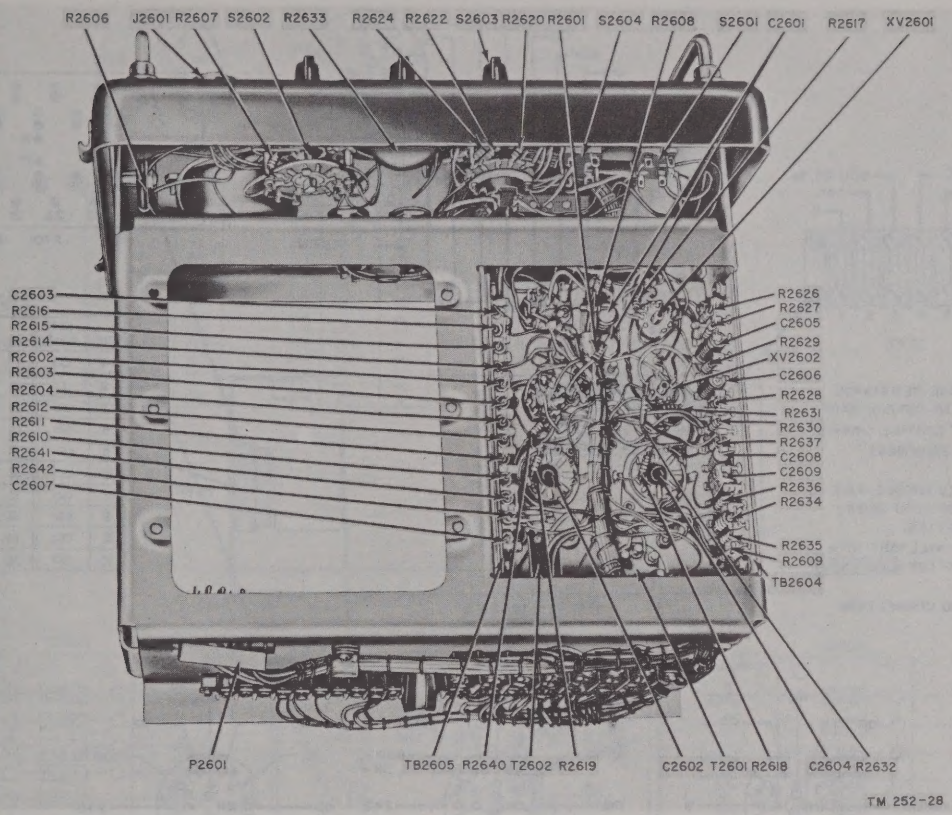


Figure 68. Radio Set Control C–845/U, bottom view of chassis.

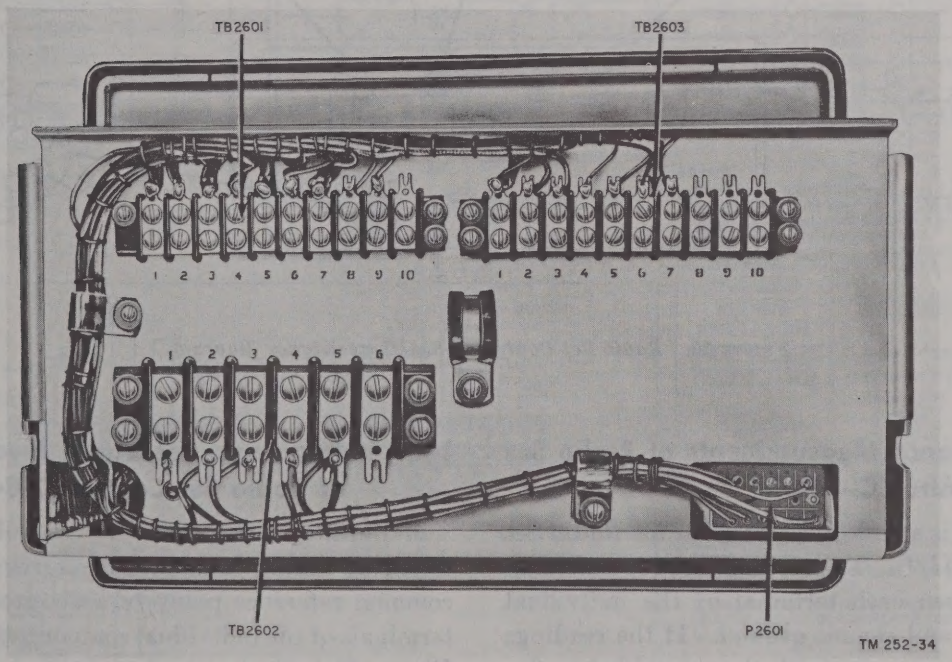
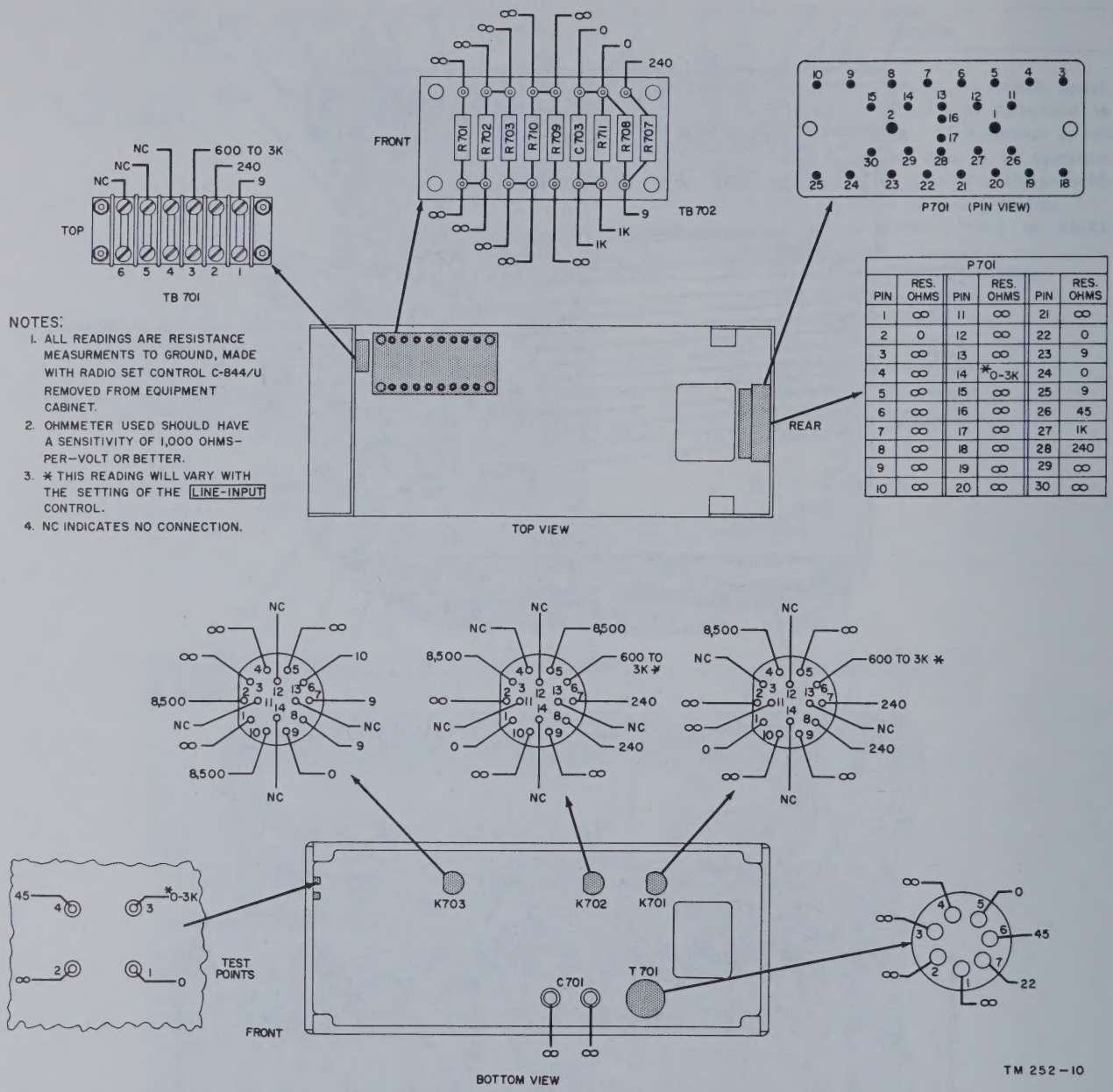


Figure 69. Radio Set Control C–845/U, rear view of chassis.



P701

PIN	RES. OHMS	PIN	RES. OHMS	PIN	RES. OHMS
1	∞	11	∞	21	∞
2	0	12	∞	22	0
3	∞	13	∞	23	9
4	∞	14	*0-3K	24	0
5	∞	15	∞	25	9
6	∞	16	∞	26	45
7	∞	17	∞	27	IK
8	∞	18	∞	28	240
9	∞	19	∞	29	∞
10	∞	20	∞	30	∞

Figure 70. Radio Set Control C-844/U, resistance diagram.

104. Resistance Measurements of Radio Set Control C-844/U

Figure 70 is a resistance diagram for Radio Set Control C-844/U. The readings are for resistance values between each terminal of the individual components and chassis ground. If the readings obtained do not agree with those specified in figure 70, within ±10 percent, the circuit is defective.

105. Voltage and Resistance Measurements of Radio Set Control C-845/U

a. Defects in the radio set control can be detected by taking resistance measurements from a common reference point (chassis ground) to the terminals of the individual components of the unit. Figure 71 indicates the nominal values of resistance at all check points. When performing the

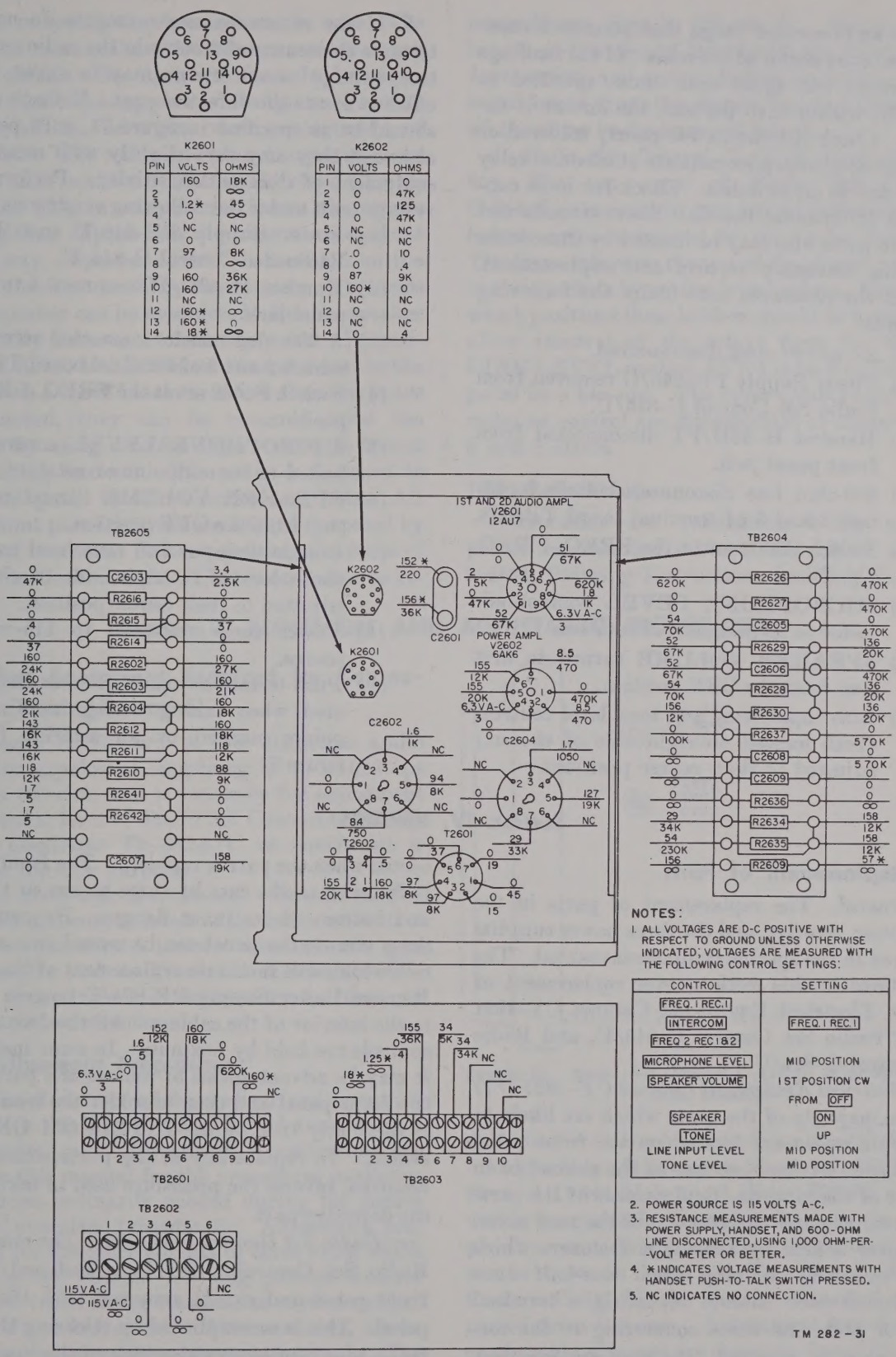


Figure 71. Radio Set Control C-845/U, voltage and resistance diagram.

test, use an ohmmeter range that permits a reading close to the center of the scale. If the readings obtained do not agree with those specified in figure 71, within ±10 percent, the circuit is defective. Check the circuit for poorly soldered or broken connections, poor contacts at tube and relay sockets and at all switches. Check for loose connections at terminal boards. Short circuits and defective parts also may be located by these tests. Make the necessary repairs and replacements. Perform the resistance tests under the following conditions:

(1) Ac power cord disconnected.
(2) Power Supply PP–846/U removed from Radio Set Control C–845/U.
(3) Handset H–33D/PT disconnected from front panel jack.
(4) 600-ohm line disconnected from terminals 2 and 3 of terminal board TB2603.
(5) Switch S2602 set at the FREQ. 1 REC. 1 position.
(6) MICROPHONE LEVEL control adjusted to its midpoint of rotation.
(7) SPEAKER VOLUME turned to first step from the OFF position.
(8) Line input level and tone level controls (both located on right side of chassis) adjusted to their center positions.

b. If the resistance measurements do not determine the source of trouble in the radio set control, voltage measurements may be taken in an effort to locate the defective part. Voltage values should be as specified in figure 71, ±10 percent, although they may vary slightly with measuring equipment of different sensitivity. Perform the voltage tests under the following conditions:

(1) Power Supply PP–846/U installed in Radio Set Control C–845/U.
(2) Handset H–33D/PT connected to front panel jack.
(3) A 600–ohm resistor connected across terminals 2 and 3 of terminal board TB2603.
(4) Switch S2602 set at the FREQ. 1 REC. 1 position.
(5) MICROPHONE LEVEL control adjusted to its midpoint of rotation.
(6) SPEAKER VOLUME turned to first step from the OFF position.
(7) Line level input and tone level controls (both located on right side of chassis) adjusted to their center position.
(8) Power cord connected to 115–volt ac source.
(9) Push-to-talk switch of the handset operated when taking voltage readings at points marked by an asterisk (*) in figure 71.

Section IV. REPAIRS

106. Replacement of Parts

a. General. The replacement of parts in the transmitter, receiver, and the three power supplies is covered in the specific component manual. The instructions in this section cover replacement of parts in Electrical Equipment Cabinet CY–1221 (*)/G, Radio Set Control C–845/U, and Radio Set Control C–844/U.

b. Electrical Equipment Cabinet CY–1221 (*)/G. The majority of the parts which are likely to need replacement are located on the front panel in the lower left hand corner of the cabinet or in the rear of the cabinet. Replacement of the parts at the rear requires the removal of the rear cover. This cover is held by Dzus-type fasteners which are released by turning them one-half turn counterclockwise. Before replacing a terminal board or jack, the wires connecting to the terminals must be removed. As they are removed, tag the wires so that they can be correctly connected when the part is replaced. The front panel is fastened to the case by three screws at the top and bottom of its inner flanges. By removing these screws, the panel can be moved into a position which will facilitate replacement of the parts. Remove Power Supply PP–804/U to gain access to the interior of the cabinet. All the front panel controls are held by hex nuts. In some instances, it may be advantageous to remove the part from the front panel and then unsolder the leads; this is especially true of the INTERCOM ON-OFF switch. To replace any of the parts which were removed, reverse the procedure used in taking out the defective part.

c. Radio Set Control C–845/U. The chassis of Radio Set Control C–845/U is fastened to the front panel and can be removed with the front panel. This is accomplished by releasing the four trunk type latches on either side of the case. The pilot lights can be changed from the front panel

without removing the chassis from the case. The tubes and neon oscillator bulbs are mounted on top of the chassis. See figure 23 for tube locations. Figure 67 shows a top view while figures 68 and 69 show a bottom and a rear view, respectively, of the chassis. The relays and plug-in capacitors are held in their sockets by flat spring clips. To remove the plug-in components, loosen the screws holding these clips so that they may be rotated out of the way. Speaker LS2601 is mounted on the rear of the front panel by four screws. The leads to the speaker can be unsoldered after the speaker is partially dismounted from the panel. Potentiometers R2613 and R2638 are mounted next to the speaker on a small bracket. After their wires are disconnected, they can be removed from the bracket by using a socket type wrench to loosen the bushing hex nut. The meter is fastened to the front panel by three screws and nuts. All other front panel controls are held to the panel by means of hex nuts. When repairing the parts of Radio Set Control C–845/U, it is advisable to remove Power Supply PP–846/U. The terminal boards at the rear of the chassis are fastened by four screws and nuts. Before removing a terminal board from the chassis, tag and disconnect all the wires to the terminal board.

d. Radio Set Control C–844/U (figs. 65 and 66). The top cover of Radio Set Control C–844/U is secured by two air-loc fasteners. The bottom cover is secured by six air-loc fasteners. The three relays on the top of the chassis are held in their sockets by spring type holders. The screw which positions these holders should be loosened to allow removal of the relays from the chassis. LINE LEVEL control AT701 is held to the front panel by a hex nut. The other components of the radio set control are disassembled as explained in *b* and *c* above.

107. Refinishing

Instructions for refinishing badly marred panels on exterior cabinets are given in TM 9–2851, Painting Instructions for Field Use.

Section V. ALINEMENT AND ADJUSTMENT PROCEDURES

108. Test Equipment Required for Component Alinement

a. Audio Oscillator. A low distortion audio oscillator capable of supplying 20 to 20,000 cps across a 600-ohm load is necessary for adjustment of the audio level of Radio Set Control C–845/U. Audio Oscillator TS–382A/U or equivalent is suitable for this purpose.

b. Ac Electronic Multimeter. Measurement of the input and output levels of the radio set control requires a sensitive ac meter. An electronic type ac voltmeter such as Electronic Multimeter TS–505/U or equivalent is satisfactory for these af voltage measurements.

109. Alinement Procedures

a. The rf circuits of the receiver and transmitter used in Radio Set AN/FRC–15 tune sharply and require precise adjustment. Instructions are given in this manual for the procedures to change frequencies ordinarily needed during the course of usual operation (chapter 3). Adjustment procedures for the other circuits of these units which normally can operate for long periods without attention (such as the transmitter crystal oscillator circuit, and if. circuits of the receiver), can be found in the respective component manuals. The alinement procedures found in this section pertain to Radio Set Controls C–844/U and C–845/U.

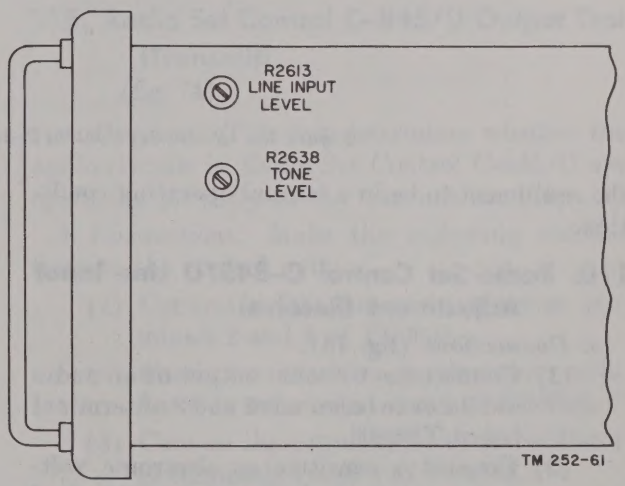


Figure 72. Radio Set Control C–845/U, internal adjustment location.

b. The only adjustment to be made in Radio Set Control C–844/U is the LINE INPUT control which is accessible through a hole in the front panel cover. This screwdriver adjustment location is shown in figure 35. To adjust Radio Set Control C–845/U, the chassis must first be removed from the case. Adjustment locations are on the right side and are shown in figure 72. The test equipment setup is similar but not identical

for all the tests of both units. Figures 73 and 74 show in block diagram form the setups used for the remote control adjustments. Additional equipment is shown which permits these illustrations to be used later for the final testing of the control units.

c. When adjusting the local control (Radio Set Control C–844/U), the radio set is connected for remote operation (par. 32). For adjustment of Radio Set Control C–845/U, the unit is connected to a 115-volt ac source, and is operated independently of the radio set. All adjustments require the equipment to be in a normal operating condition.

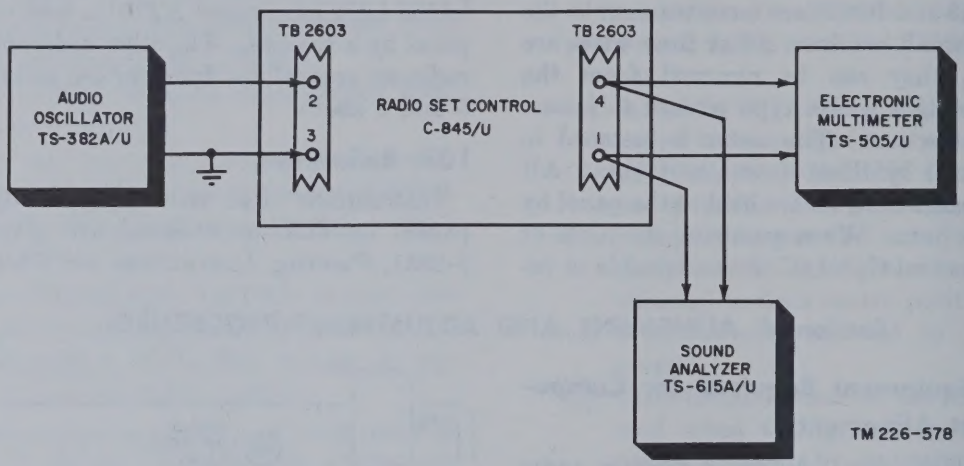


Figure 73. Radio Set Control C–845/U, set up for input adjustment.

110. Radio Set Control C–845/U Line Input Adjustment (Receive)

a. Connections (fig. 73).

(1) Connect the 600-ohm output of an audio oscillator to terminals 2 and 3 of terminal board TB2603.

(2) Connect a sensitive ac electronic voltmeter to terminals 2 and 3 of terminal board TB2603.

b. Control Settings. Set the front panel controls as follows:

Control	Position
SPEAKER VOLUME	Fully clockwise.
Frequency selector-intercom switch.	FREQ. 1 REC. 1.
MICROPHONE LEVEL	Any position.
TONE	Leave in the off position (up).
SPEAKER	ON.

c. Procedure. Apply power to Radio Set Control C–845/U and perform the following operations to set the line input level control R2613:

(1) Adjust the audio oscillator frequency to 1,000 cps and set the output to indicate .62 volt on the ac electronic voltmeter.

(2) Connect the multimeter to terminals 1 and 4 of terminal board TB2603.

(3) Adjust the line input level control to cause an indication of 2 volts on the external ac electronic voltmeter.

111. Radio Set Control C–845/U Tone Adjustment

a. Connections. Connect a 600-ohm resistor across terminals 2 and 3 of TB2603.

b. Control Settings. Set the front panel controls as follows:

Control	Position
SPEAKER VOLUME	First position from OFF.
MICROPHONE LEVEL	Any position.
TONE	Leave in the off position (up).
Frequency selector-intercom switch.	INTERCOM.

c. Procedure. Apply power to Radio Set Control C–845/U and perform the following steps:

(1) Operate the TONE switch to the on position (down).

(2) Adjust the tone level control R2638 to cause the LINE LEVEL meter to indicate −2 dbm.

112. Radio Set Control C–844/U Line Input Adjustment

a. Connections.

(1) Connect the radio set for remote operation as described in paragraph 32.

(2) Connect a sensitive ac electronic multimeter to front panel test points 1 and 3 on Radio Set Control C–844/U.

b. Control Settings. Place the radio set controls in the proper positions for remote operation as described in paragraph 50.

c. Procedure.

(1) Establish contact with the operator at the remote control unit. Have the remote control operator perform the tone adjustment as described in paragraph 111.

(2) Instruct the remote control operator to select FREQ. 1 REC. 1 operation, and to simultaneously press the TONE switch and the push-to-talk switch on the handset. The local operator must release the INTERCOM. ON-OFF switch before proceeding with the following step.

(3) Adjust the LINE INPUT control AT701 to provide a .35 volt ac reading on the electronic multimeter.

Section VI. FINAL TESTING

113. General

This section is intended to serve as a guide for determining the performance of a repaired Radio Set Control C–844/U or C–845/U. The minimum test requirements are given as standards which allow the performance of the units to be evaluated. In general, the units and test equipment are connected in the same manner as they are for the alinement and adjustment procedures. Refer to figures 73 and 74 for illustrations of the test setups. The testing procedures do not require any adjustments of the control units, but they determine whether the characteristics are as specified for new units of equipment.

114. Test Equipment Required for Final Testing

The instruments required for testing are listed below:

a. Audio Oscillator. A low distortion audio oscillator capable of supplying 20 to 20,000 cps across a 600-ohm load is necessary for checking levels, frequency response, and distortion of Radio Set Controls C–844/U and C–845/U. Audio Oscillator TS–382/U or its equivalent is required for these uses.

b. Ac Electronic Multimeter. Low audio levels normally are encountered in the radio set controls; therefore, a sensitive ac electronic multimeter is necessary to test these circuits. A meter such as Electronic Multimeter ME–6A/U or equivalent is satisfactory for such voltage measurements.

c. Distortion Analyzer. Only a certain amount of distortion can be tolerated in the audio circuits of the radio set, otherwise reception and transmission will be garbled. To measure audio distortion, a distortion analyzer such as Sound Analyzer TS–615A/U or equivalent is required.

115. Radio Set Control C–845/U Output Test (Transmit)

(fig. 74)

a. Purpose. This test determines whether the audio circuits in Radio Set Control C–845/U are operating properly in the transmit condition.

b. Connections. Make the following connections to the control unit:

(1) Connect a 600-ohm resistor across terminals 2 and 3 of TB2603.

(2) Connect a sensitive ac electronic voltmeter to terminals 1 and 6 of TB2603.

(3) Connect the output of an audio oscillator to terminals 1 and 6 of TB2603.

c. Control Settings. Set the front panel controls as follows:

Control	Position
Frequency selector-intercom switch.	INTERCOM.
SPEAKER VOLUME	To first clockwise position from OFF.
MICROPHONE LEVEL	As directed in *d* below.
TONE	Leave in off position (up).

d. Procedure.

(1) Set the audio oscillator output to .1 volt as read on the ac electronic voltmeter.

(2) Move the ac electronic voltmeter leads to terminals 2 and 3 of TB2603.

(3) Press the handset push-to-talk switch and adjust the MICROPHONE LEVEL control to indicate .6 volt on the ac electronic voltmeter (this reading should coincide with −2 dbm on the LINE LEVEL front panel meter).

e. Requirements.

(1) With the handset push-to-talk switch pressed, it should be possible to change the audio oscillator frequency (maintaining .1-volt oscillator output) through the frequency range of 100 to 3,500 cps without the LINE LEVEL meter reading varying more than ±1.5 dbm.

(2) Disconnect the audio oscillator and the vacuum tube voltmeter from the circuit. Do not disturb the control settings on the control unit. Use the Sound Analyzer TS–615/U to obtain an output reading while the handset push-to-talk switch is pressed. This reading is the hum level in the transmit direction. It should be below .0019 volt (1.9 millivolt) or −50 db.

116. Radio Set Control C–845/U Input Test (Receive)

(fig 73)

a. Purpose. This test will determine whether the control unit audio circuit is operating properly in the receive condition.

b. Connections. Make the following connections to the control unit:

(1) Connect the 600-ohm output of an audio oscillator to terminals 2 and 3 of TB2603.

(2) Connect a sensitive ac electronic voltmeter to terminals 2 and 3 of TB2603.

c. Control Setting. Set the front panel controls as follows:

Control	Position
Frequency selector-intercom switch.	FREQ. 1 REC. 1.
SPEAKER VOLUME	Fully clockwise.
MICROPHONE LEVEL	Any position.
TONE	Off (up) position.

d. Procedure. Set the audio oscillator to 1,000 cps and adjust its output to indicate .62 volt on the ac electronic voltmeter. Connect the ac electronic voltmeter across terminals 1 and 4 of TB2603. Connect the distortion analyzer in parallel with the voltmeter.

e. Requirements.

(1) A reading of 2 volts should be obtained on the ac electronic voltmeter. The distortion of the signal should be less than 10 percent.

(2) Remove the audio oscillator and the vacuum tube voltmeter and set the frequency selector-intercom switch to INTERCOM. The Sound Analyzer TS–615/U is used to read the hum level. This level should be less than .0019 volt or −50 db.

117. Radio Set Control C–845/U Tone Test

a. Purpose. This test indicates whether the tone signal is at the correct frequency and whether the level is correct to properly modulate the transmitter.

b. Connections. Connect a 600-ohm resistor across terminals 2 and 3 of TB2603.

c. Control Settings. Set the front panel controls as follows:

Control	Position
SPEAKER VOLUME	First position clockwise from OFF.
Frequency selector-intercom switch.	INTERCOM.
MICROPHONE LEVEL	Any position.
TONE	Leave in the off position (up).
SPEAKER	ON.

d. Procedure. Press the TONE switch to the on position (down).

e. Requirements. When the TONE switch is pressed, the tone should be heard at the speaker and the handset earpiece. If the frequency is compared with an audio oscillator, it should be approximately 1,000 cps. By pressing the push-to-talk switch, the tone will be cut off at the speaker, but will cause a −2 dbm indication on the LINE LEVEL meter. This indicates that the proper level is present at the input to the audio line.

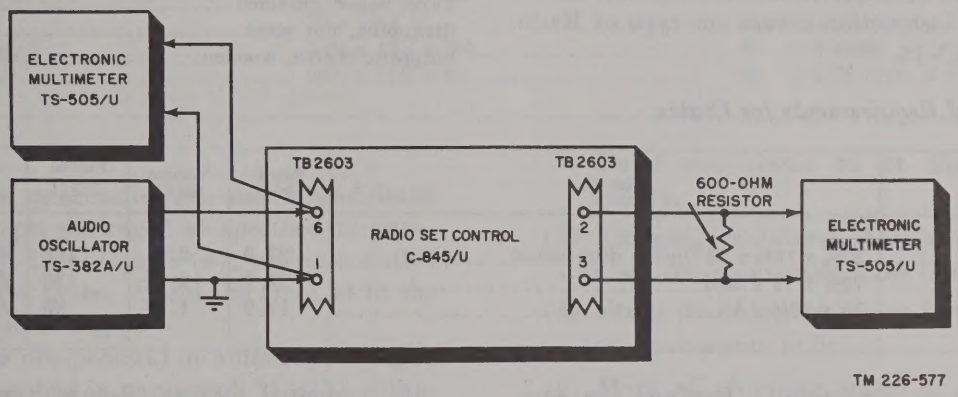


Figure 74. Radio Set Control C–845/U, setup for output adjustment.

CHAPTER 7

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. FIELD PACKAGING

118. Procedures

a. Purpose and Scope. The purpose of this instruction is to provide procedures for field packaging and packing and marking of the subject item for Zone of Interior and intertheater movement. This instruction covers one type of Radio Set AN/FRC–15.

b. Estimated Material Requirements.

Materials	Quantity
Waterproof barrier material	50 sq ft
Paper, single-face, flexible, corrugated	180 sq ft
Tape, pressure-sensitive	46 ft
Tape, paper, gummed	48 ft
Strapping, flat steel	35 ft
Shipping crates, wooden	3

c. Material Requirements for Crates.

Crate No.	Size (in.)	Board-feet	Volume (cu ft)	Packed weight (lb)	Contents
1 of 3	22¼ x 18¾ x 23 (inside dimension)	23. 9	8. 2	188	Radio Set.
2 of 3	22¾ x 19 x 26¼	27. 2	9. 51	130	Pedestal.
3 of 3	30 x 12½ x 5½	11. 9	1. 87	80	Antenna.

d. Component Packaging. Package the components of Radio Set AN/FRC–15 as follows:

(1) *Technical manuals.* Package each technical manual as follows: Inclose each manual within a close-fitting bag fabricated from waterproof-barrier material. Seal the seams with water resistant, pressure-sensitive tape.

(2) *Accessories and spare parts items.* Package each item individually by wrapping them with flexible, single-faced corrugated paper. Secure the wrapping with gummed paper tape.

(3) *Consolidated package.* Consolidate the items, packaged as specified in (1) and (2) above, within a wrap of flexible single-faced corrugated paper. Seal the folds and seams with gummed paper tape.

(4) *Radio set.* Cushion each radio set by wrapping it in flexible single-faced corrugated paper. Secure the cushioning with gummed paper tape.

(5) *Antenna pedestal.* Wrap each item individually in flexible single-faced corrugated paper. Secure the wrapping with gummed paper tape.

119. Packaging and Packing

(figs. 16, 17, and 18)

a. Domestic Immediate Use. Components of Radio Set AN/FRC–15 are preserved and packaged to afford protection against deterioration and damage during shipment.

b. Domestic Limited Storage. Components of Radio Set AN/FRC–15 are preserved and adequately cushioned to provide protection from damage in transit and storage.

c. Military Oversea. Packaging of Radio Set AN/FRC–15 for oversea is as follows. The pedestal and antenna are each cushioned and placed within an individual water-resistant fiberboard box and properly sealed. The radio set is adequately cushioned and inclosed with desiccant within a corrugated fiberboard box. The sealed box is placed within a waterproof-vaporproof barrier and heat-sealed. The water-vaporproofed radio set, together with packaged spare parts and

accessories are placed within an outer water-resistant fiberboard box which is sealed with waterproof tape.

e. Domestic Shipment for Immediate Use. Radio Set AN/FRC–15 is packed within shipping containers meeting the requirements of Consolidated Freight Classification Regulations.

f. Domestic Shipment for Limited Storage. Radio Set AN/FRC–15 is packed within wood-cleated plywood or nailed wooden crates.

g. Military Oversea Shipment. Radio Set AN/FRC–15 is packed with three wood cleated plywood or nailed wooden crates, reinforced with flat steel strapping. The size, weight and volume of the bare, export packaged and packed items are shown below:

Contents	Size	Weight (lb)	Volume (cu ft)
Radio Set (bare)	20½ x 17 x 21¼	136. 5	4.285.
Radio Set (packaged)	23½ x 20 x 25⅜	167	6.901.
Radio Set (packed)	47⅝ x 22 x 27¾	300	16.7154 crate 1 of 3.
Pedestal (bare)	21 x 16½ x 23	74	4.608.
Pedestal (packaged)	22½ x 18¾ x 26	83	6.3418.
Pedestal (packed)	26¼ x 20⅞ x 28	130	8.879 crate 2 of 3.
Antenna (bare)	29 x 12 x 5	49. 5	1.006.
Antenna (packaged)	29⅝ x 12¼ x 5¼	66	1.1025.
Antenna (packed)	36⅜ x 15¼ x 8¼	88	2.75 crate 3 of 3.

h. Packing.

(1) Place one radio set and consolidated package, packaged as specified in paragraph 118*c*(3) and (4), within a nailed wooden crate. Build the crate to fit the contents snugly.

(2) Place one pedestal or antenna, packaged as specified in paragraph 118*c*(5) within an individual nailed wooden crate. Build the crates to fit the contents snugly.

(3) Shipping containers shall be fitted with a sealed, waterproof, case liner.

(4) Strap the shipping crates for intertheater movements only.

(5) Mark all shipping crates in accordance with the requirements of SR 55–720–1.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

120. General

The demolition procedures outlined below will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

121. Methods of Destruction

a. Smash. Smash capacitors, transformers, resistors, sockets, terminal boards, and plugs; use sledges, axes, pickaxes, hammers, crowbars, or other heavy tools.

b. Cut. Cut wiring; use axes, handaxes, or machetes.

c. Burn. Burn technical literature, resistors, capacitors, and transformers; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend chassis, panels, and covers.

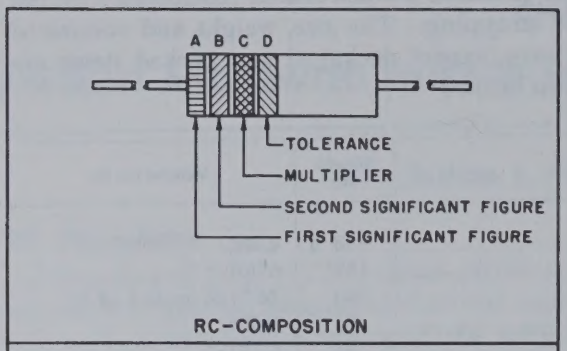
e. Explode. If explosives are necessary, use firearms, grenades, or TNT.

f. Dispose. Bury or scatter the destroyed parts in slit trenches, fox holes or other holes, or throw them into streams.

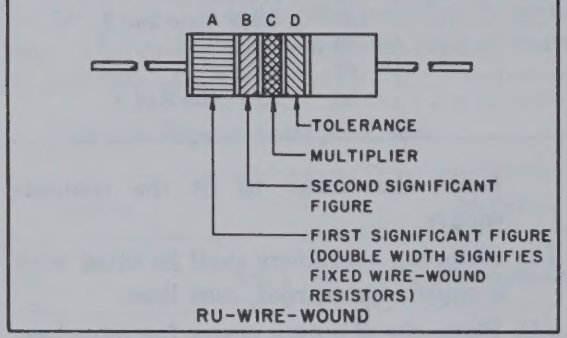
g. Destroy. Destroy everything.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)

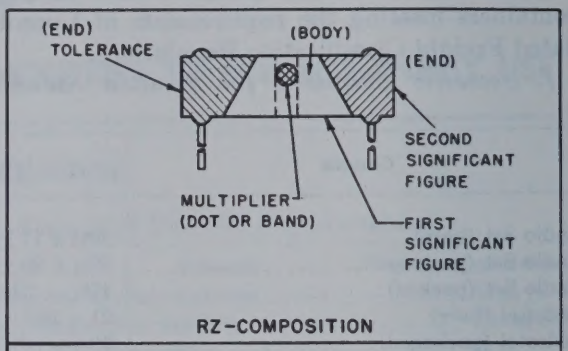


RC-COMPOSITION

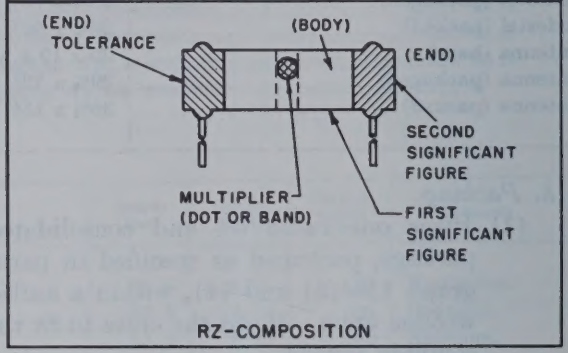


RU-WIRE-WOUND

RADIAL-LEAD RESISTORS (UNINSULATED)



RZ-COMPOSITION



RZ-COMPOSITION

RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	±20
BROWN	1	BROWN	1	BROWN	10	SILVER	±10
RED	2	RED	2	RED	100	GOLD	±5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

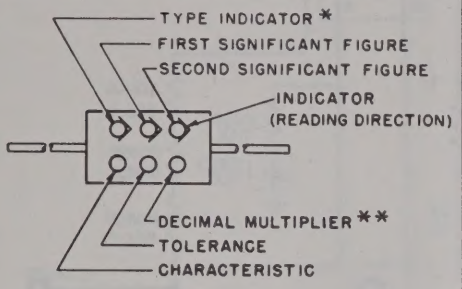
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-R1

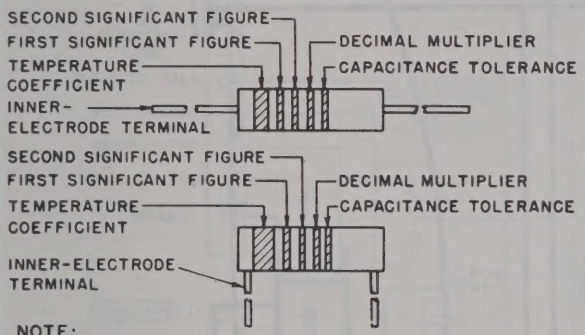
Figure 75. MIL-STD resistor color codes.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



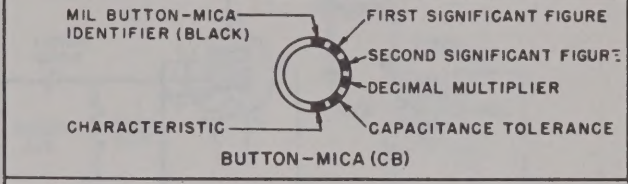
* BLACK DOT: MICA DIELECTRIC
SILVER DOT: PAPER DIELECTRIC
** INDICATES NUMBER OF ZEROS ON PAPER TYPE.

MICA (CM) AND PAPER (CN)

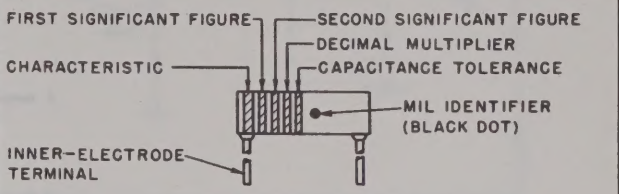


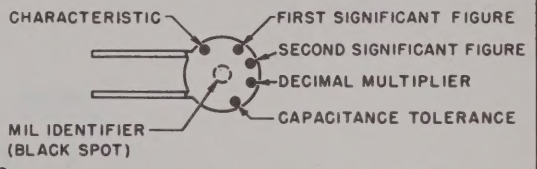
NOTE:
SPOTS MAY BE USED INSTEAD OF BANDS, TEMPERATURE COEFFICIENT MARKING IS LARGER.

CERAMIC-TEMPERATURE COMPENSATING (CC)



BUTTON-MICA (CB)





NOTES:
1. SPOTS MAY BE USED ON TUBULAR CAPACITORS; CHARACTERISTIC SPOT IS LARGER AND MIL IDENTIFIER IS ON SIDE DIAMETRICALLY OPPOSITE COLOR SPOTS.
2. MIL IDENTIFIER OF DISK TYPE IS ON REVERSE SIDE; CHARACTERISTIC SPOT IS LARGER OR SPACE BETWEEN CHARACTERISTIC AND TOLERANCE SPOTS IS THREE TIMES SPACE BETWEEN ADJACENT SPOTS.
3. TOLERANCE: YELLOW, +100%, -20%.

CERAMIC-GENERAL PURPOSE (CK)

CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE [2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) [3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION

STD-CI

Figure 76. MIL-STD capacitor color codes.

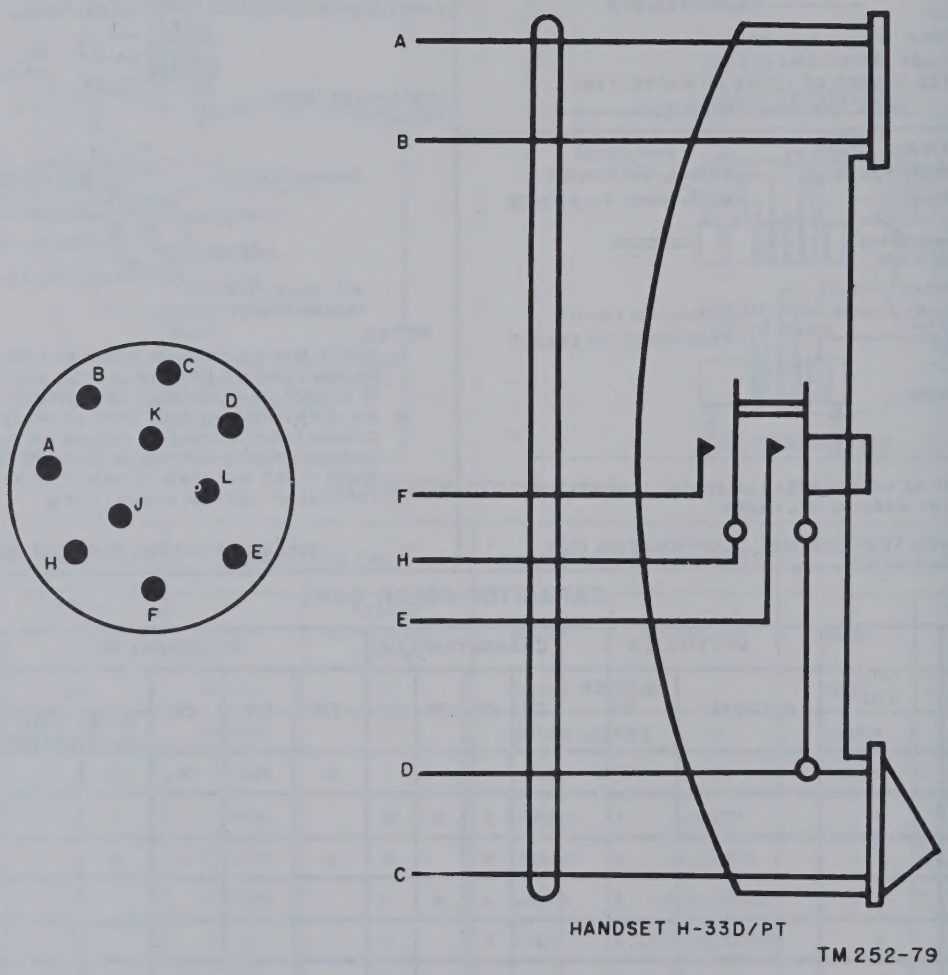
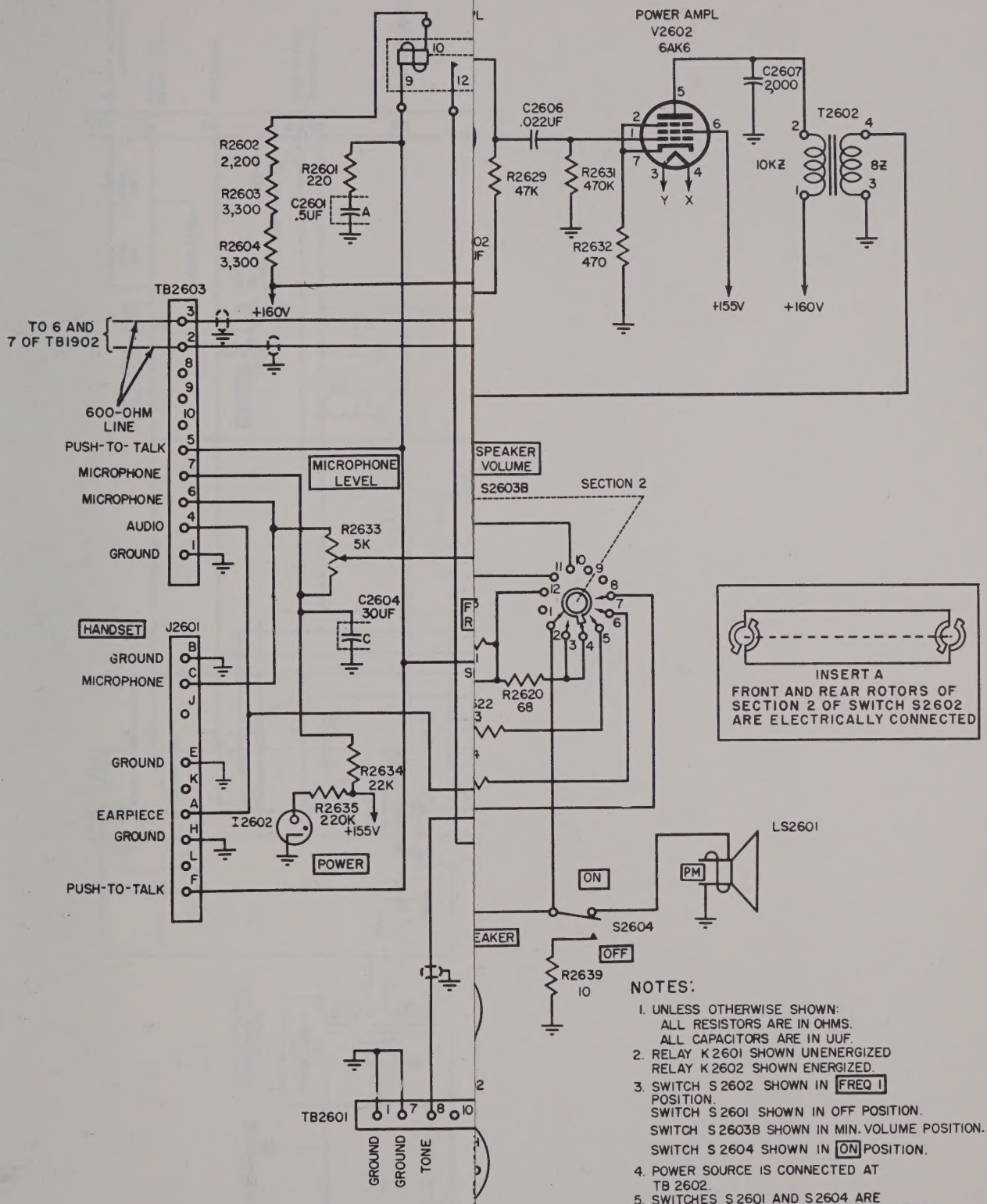


Figure 77. Handset H–33D/PT, schematic diagram.



NOTES:

1. UNLESS OTHERWISE SHOWN:
   ALL RESISTORS ARE IN OHMS.
   ALL CAPACITORS ARE IN UUF.
2. RELAY K 2601 SHOWN UNENERGIZED
   RELAY K 2602 SHOWN ENERGIZED.
3. SWITCH S 2602 SHOWN IN FREQ 1 POSITION.
   SWITCH S 2601 SHOWN IN OFF POSITION.
   SWITCH S 2603B SHOWN IN MIN. VOLUME POSITION.
   SWITCH S 2604 SHOWN IN ON POSITION.
4. POWER SOURCE IS CONNECTED AT TB 2602.
5. SWITCHES S 2601 AND S 2604 ARE SPRING RETURN TO THE OFF POSITION.
6. PLUG & SOCKETS VIEWED FROM WIRED SIDE.
7. ALL ROTARY SWITCHES VIEWED FROM END OPPOSITE CONTROL KNOB.

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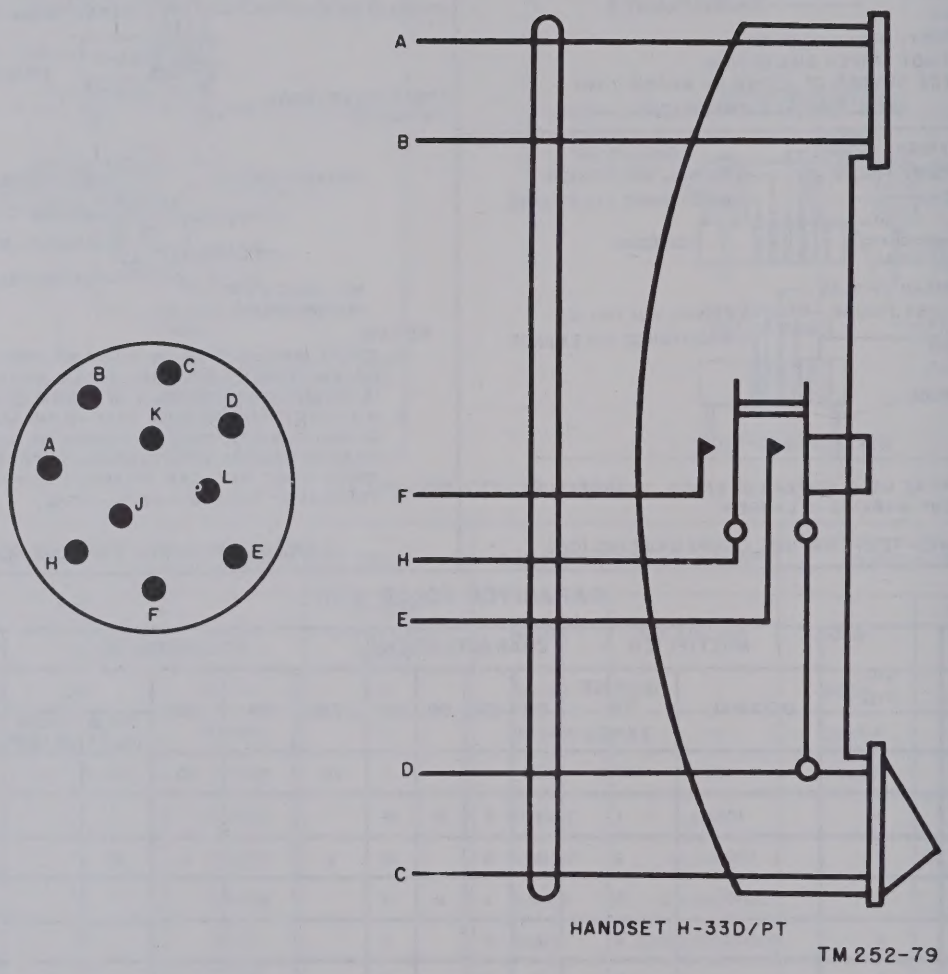
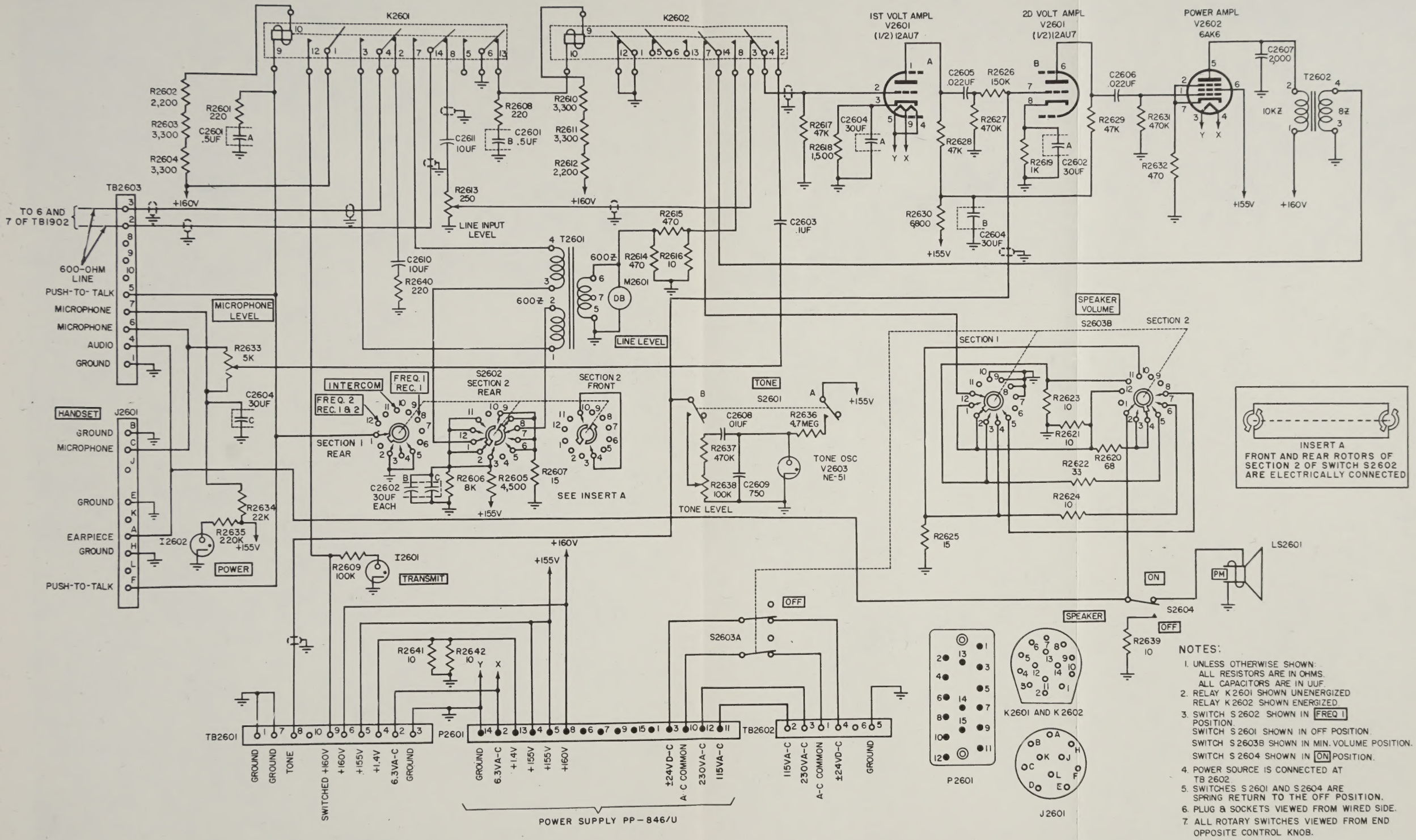


Figure 77. Handset H–33D/PT, schematic diagram.

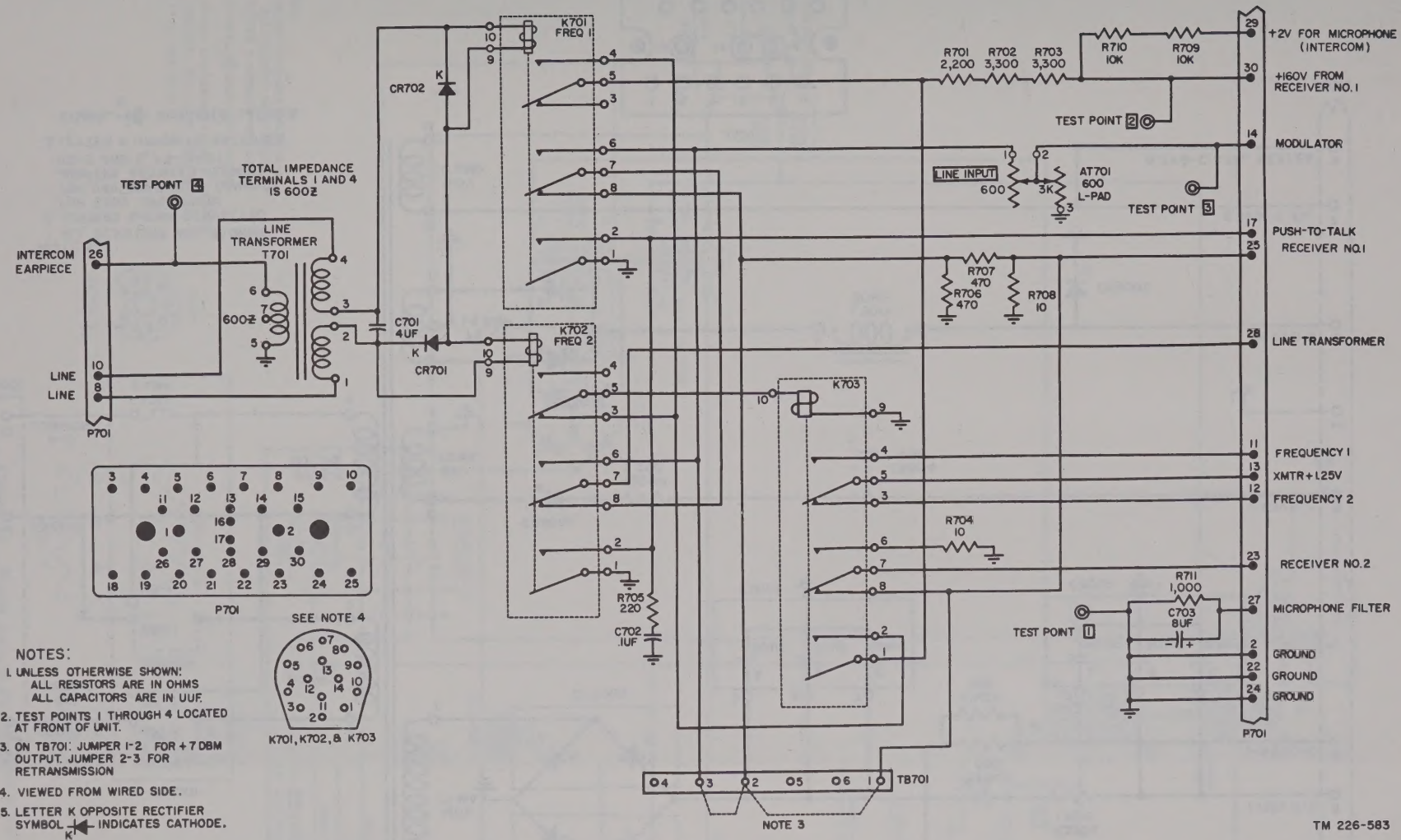


NOTES:

1. UNLESS OTHERWISE SHOWN:
   ALL RESISTORS ARE IN OHMS.
   ALL CAPACITORS ARE IN UUF.
2. RELAY K2601 SHOWN UNENERGIZED
   RELAY K2602 SHOWN ENERGIZED.
3. SWITCH S2602 SHOWN IN FREQ 1 POSITION.
   SWITCH S2601 SHOWN IN OFF POSITION.
   SWITCH S2603B SHOWN IN MIN. VOLUME POSITION.
   SWITCH S2604 SHOWN IN ON POSITION.
4. POWER SOURCE IS CONNECTED AT TB2602.
5. SWITCHES S2601 AND S2604 ARE SPRING RETURN TO THE OFF POSITION.
6. PLUG & SOCKETS VIEWED FROM WIRED SIDE.
7. ALL ROTARY SWITCHES VIEWED FROM END OPPOSITE CONTROL KNOB.

TM 282-10

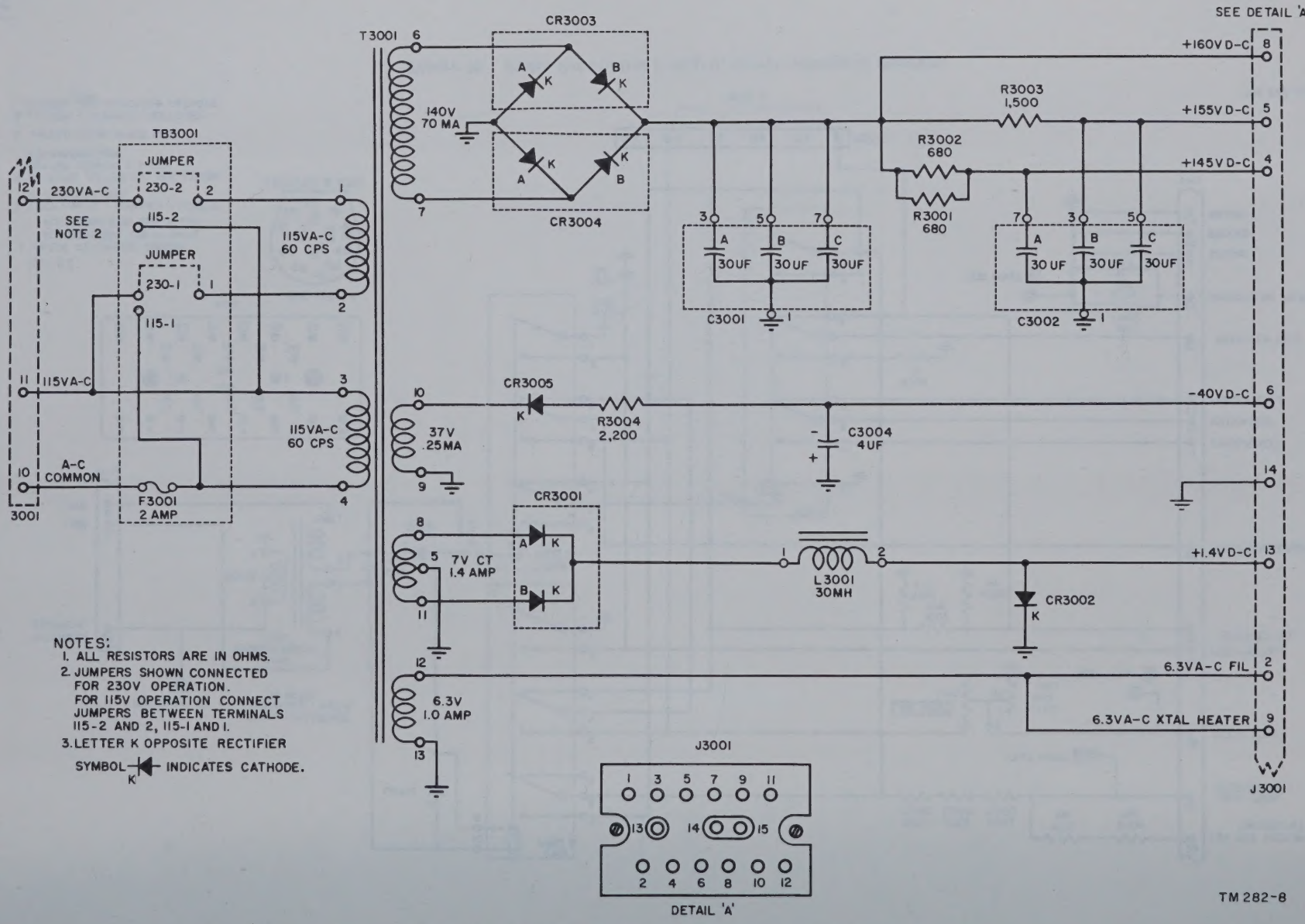
Figure 79. Radio Set Control C-845/U, overall schematic diagram.



NOTES:

1. UNLESS OTHERWISE SHOWN:
   ALL RESISTORS ARE IN OHMS
   ALL CAPACITORS ARE IN UUF.
2. TEST POINTS 1 THROUGH 4 LOCATED AT FRONT OF UNIT.
3. ON TB701: JUMPER 1-2 FOR +7 DBM OUTPUT. JUMPER 2-3 FOR RETRANSMISSION
4. VIEWED FROM WIRED SIDE.
5. LETTER K OPPOSITE RECTIFIER SYMBOL ⊣◀ INDICATES CATHODE.

Figure 78. Radio Set Control C-844/U, overall schematic diagram.



NOTES:
1. ALL RESISTORS ARE IN OHMS.
2. JUMPERS SHOWN CONNECTED FOR 230V OPERATION. FOR 115V OPERATION CONNECT JUMPERS BETWEEN TERMINALS 115-2 AND 2, 115-1 AND 1.
3. LETTER K OPPOSITE RECTIFIER SYMBOL INDICATES CATHODE.

Figure 80. Power Supply PP–846/U, overall schematic diagram.

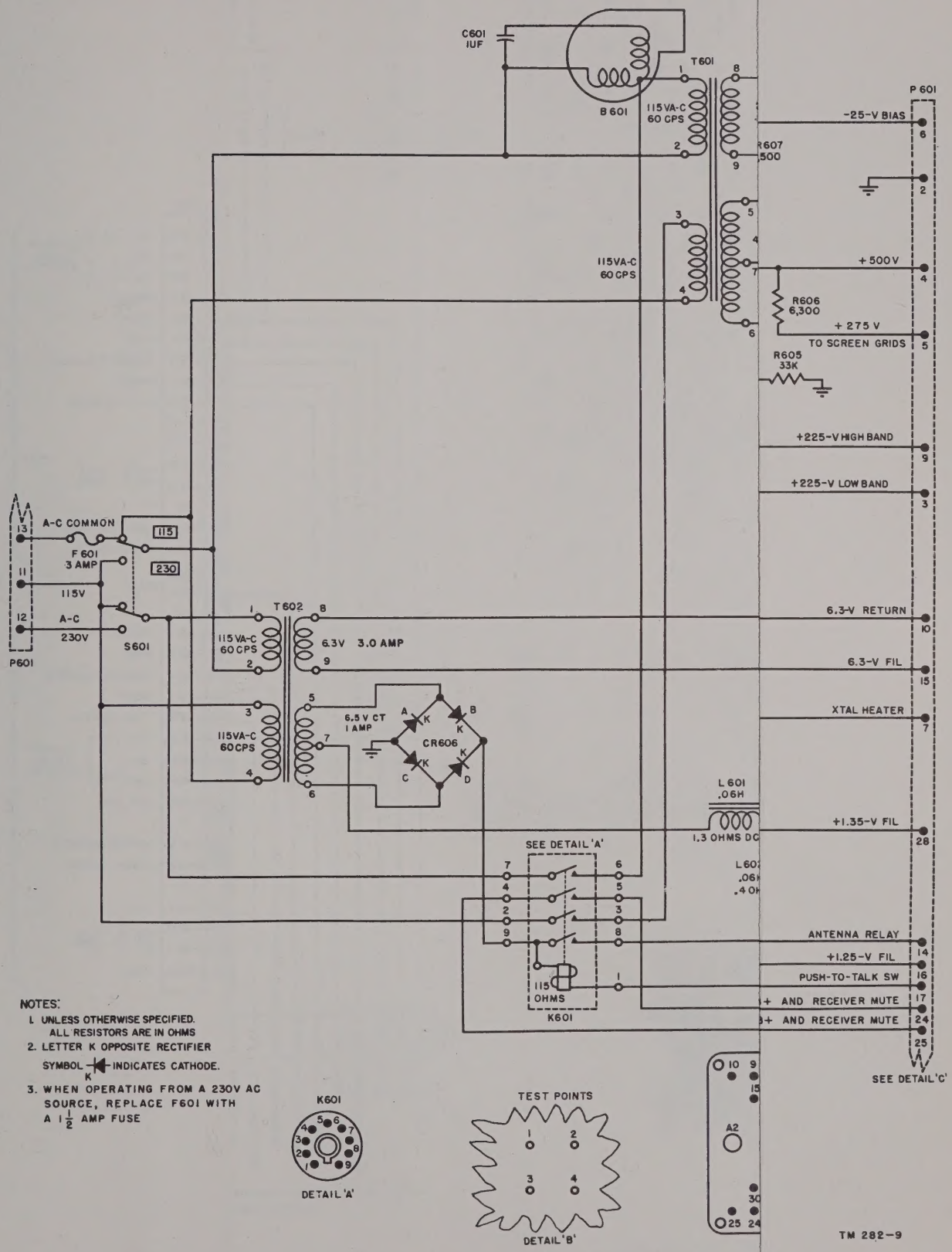


Figure 81. Power Supply PP-804/U

(See p. 120)

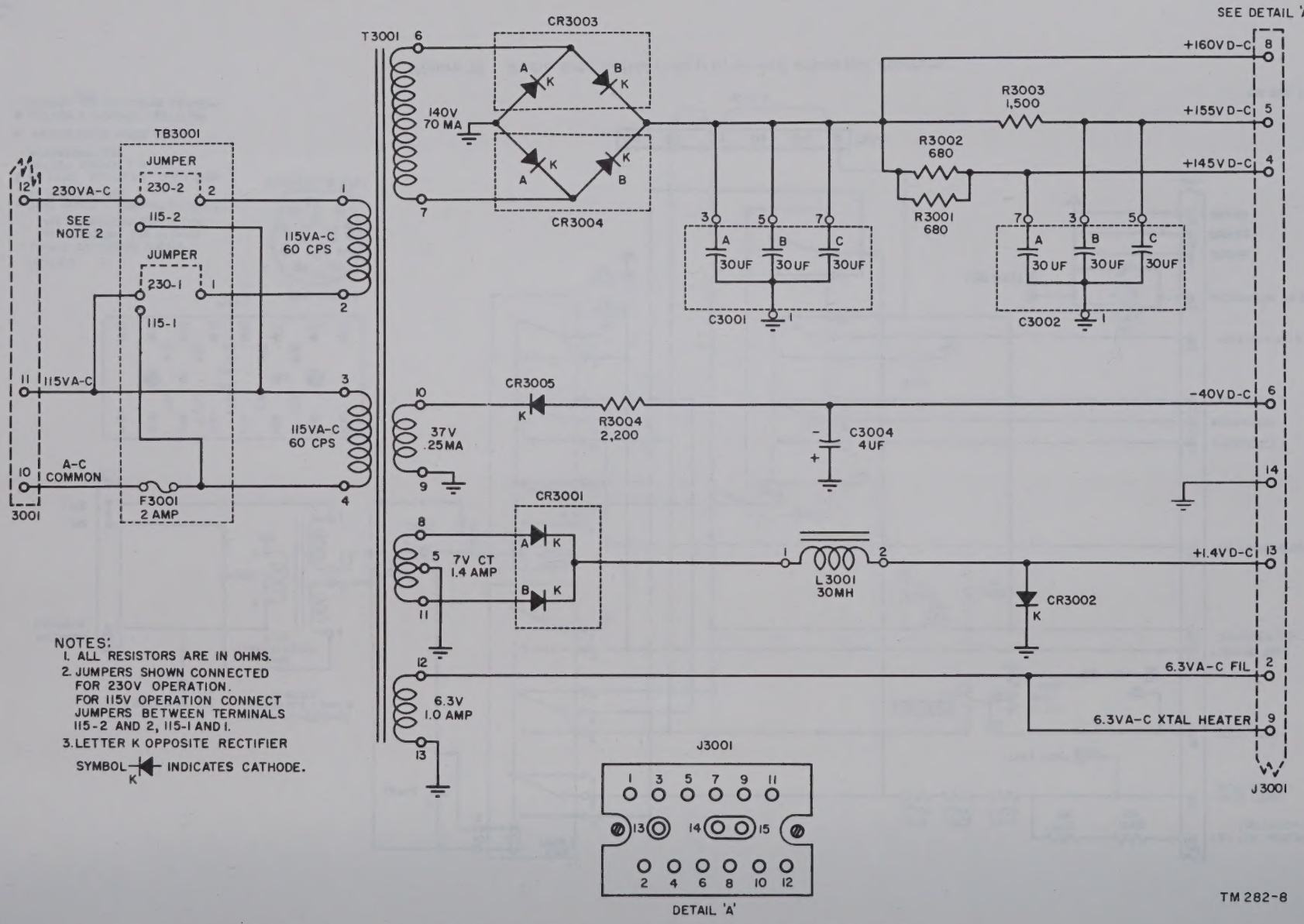


Figure 80. Power Supply PP–846/U, overall schematic diagram.

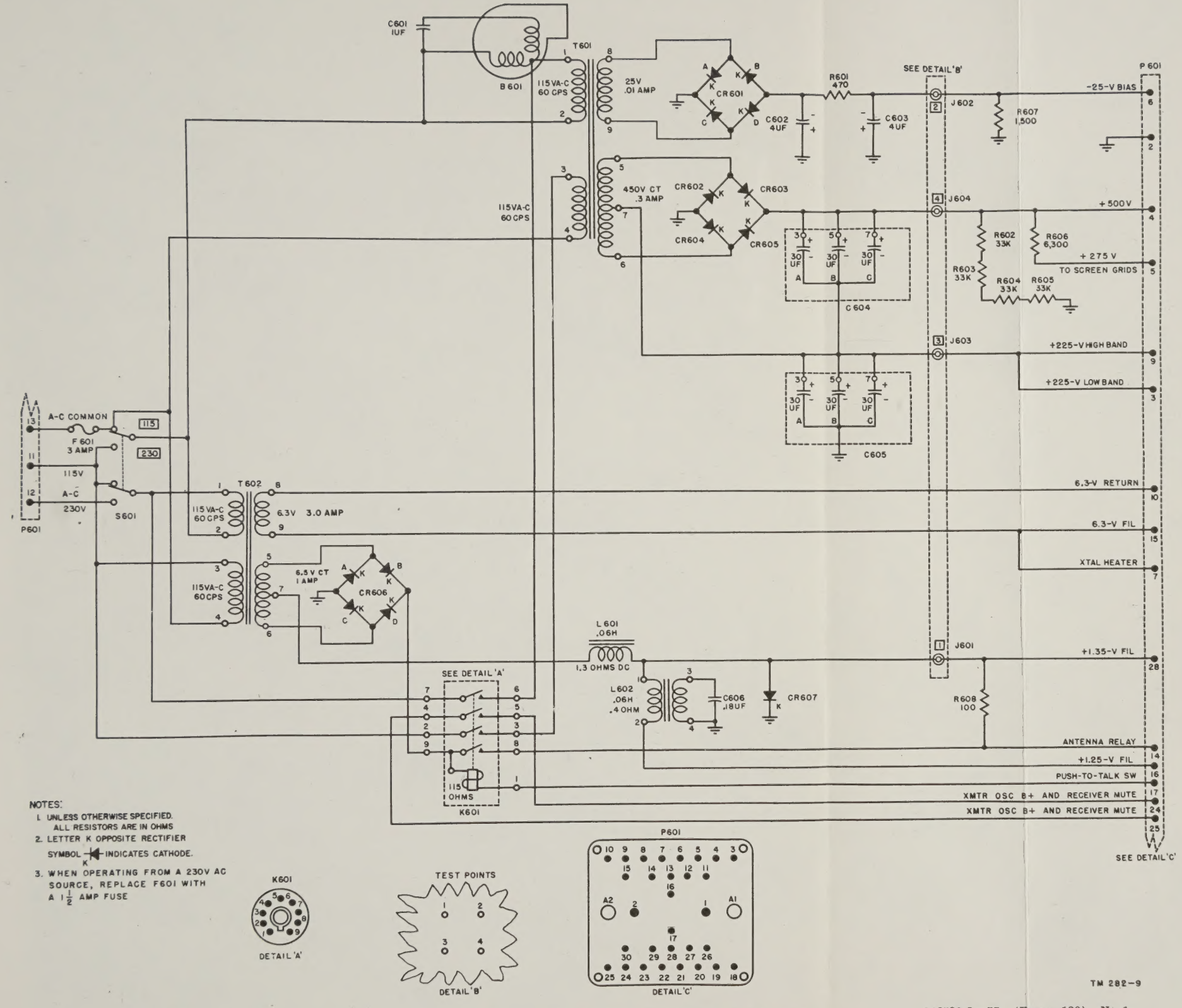
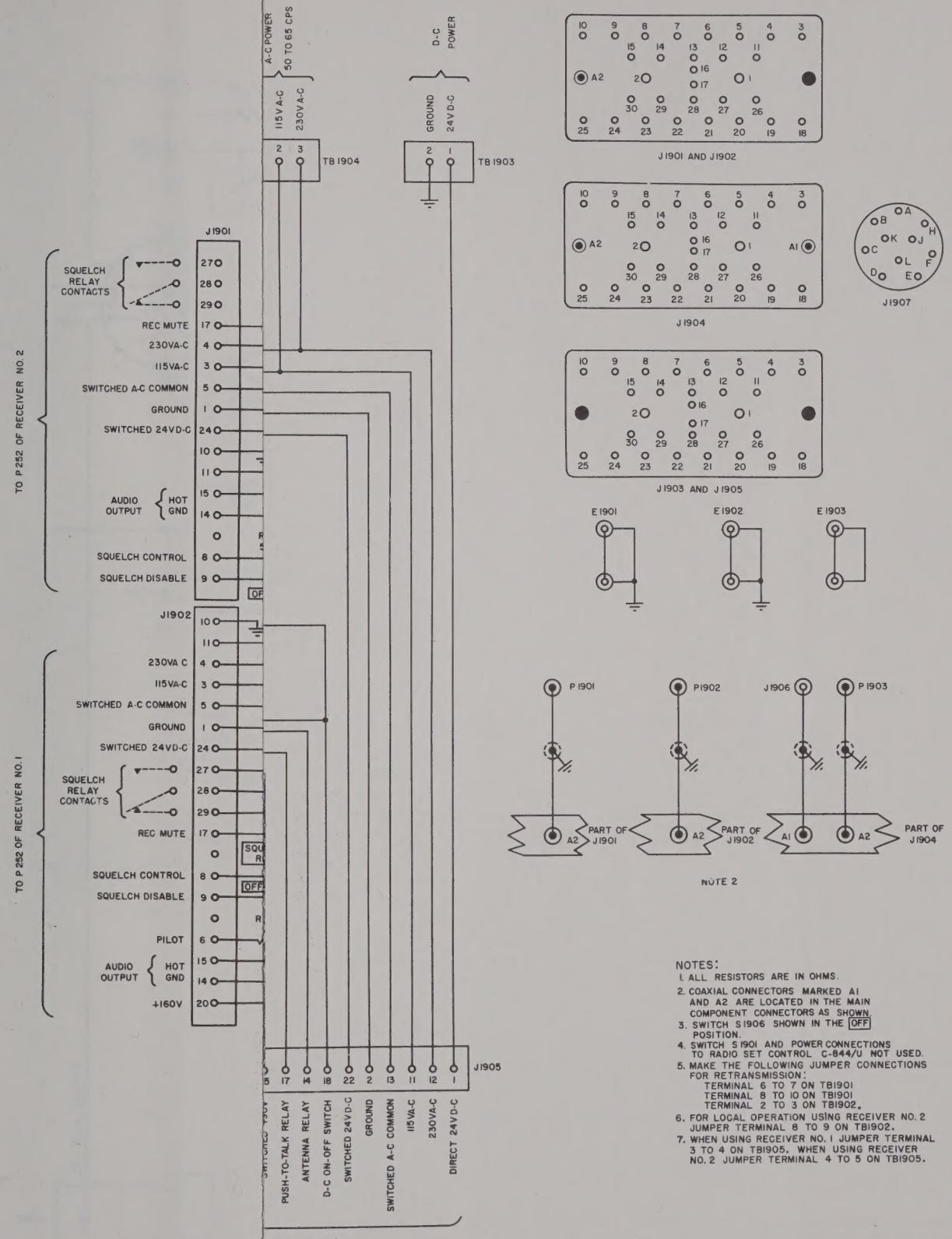


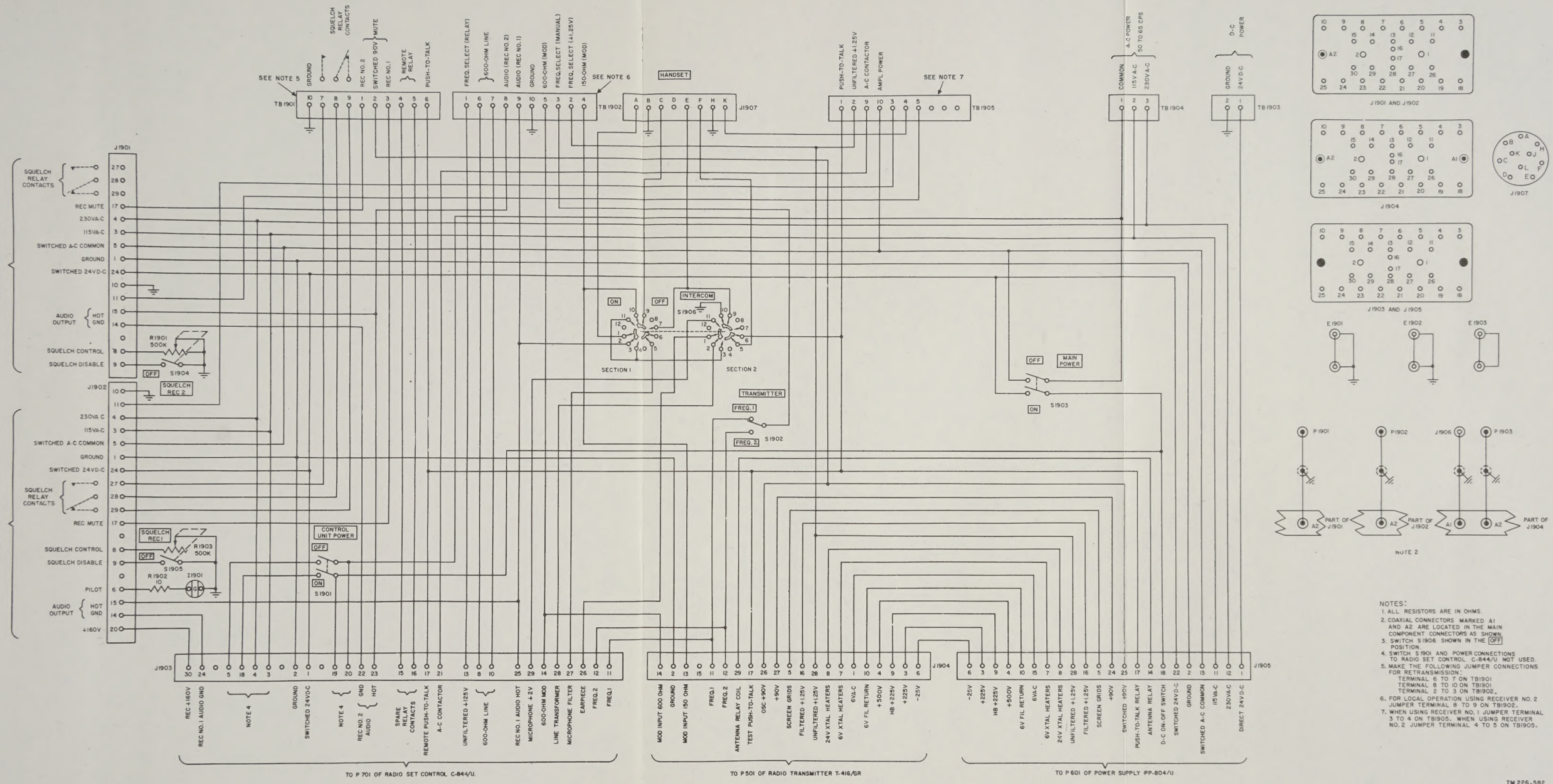
Figure 81. Power Supply PP-804/U, overall schematic diagram.



NOTES:

1. ALL RESISTORS ARE IN OHMS.
2. COAXIAL CONNECTORS MARKED A1 AND A2 ARE LOCATED IN THE MAIN COMPONENT CONNECTORS AS SHOWN.
3. SWITCH S1906 SHOWN IN THE OFF POSITION.
4. SWITCH S1901 AND POWER CONNECTIONS TO RADIO SET CONTROL C-844/U NOT USED.
5. MAKE THE FOLLOWING JUMPER CONNECTIONS FOR RETRANSMISSION:
   TERMINAL 6 TO 7 ON TB1901
   TERMINAL 8 TO 10 ON TB1901
   TERMINAL 2 TO 3 ON TB1902.
6. FOR LOCAL OPERATION USING RECEIVER NO. 2 JUMPER TERMINAL 8 TO 9 ON TB1902.
7. WHEN USING RECEIVER NO. 1 JUMPER TERMINAL 3 TO 4 ON TB1905. WHEN USING RECEIVER NO. 2 JUMPER TERMINAL 4 TO 5 ON TB1905.

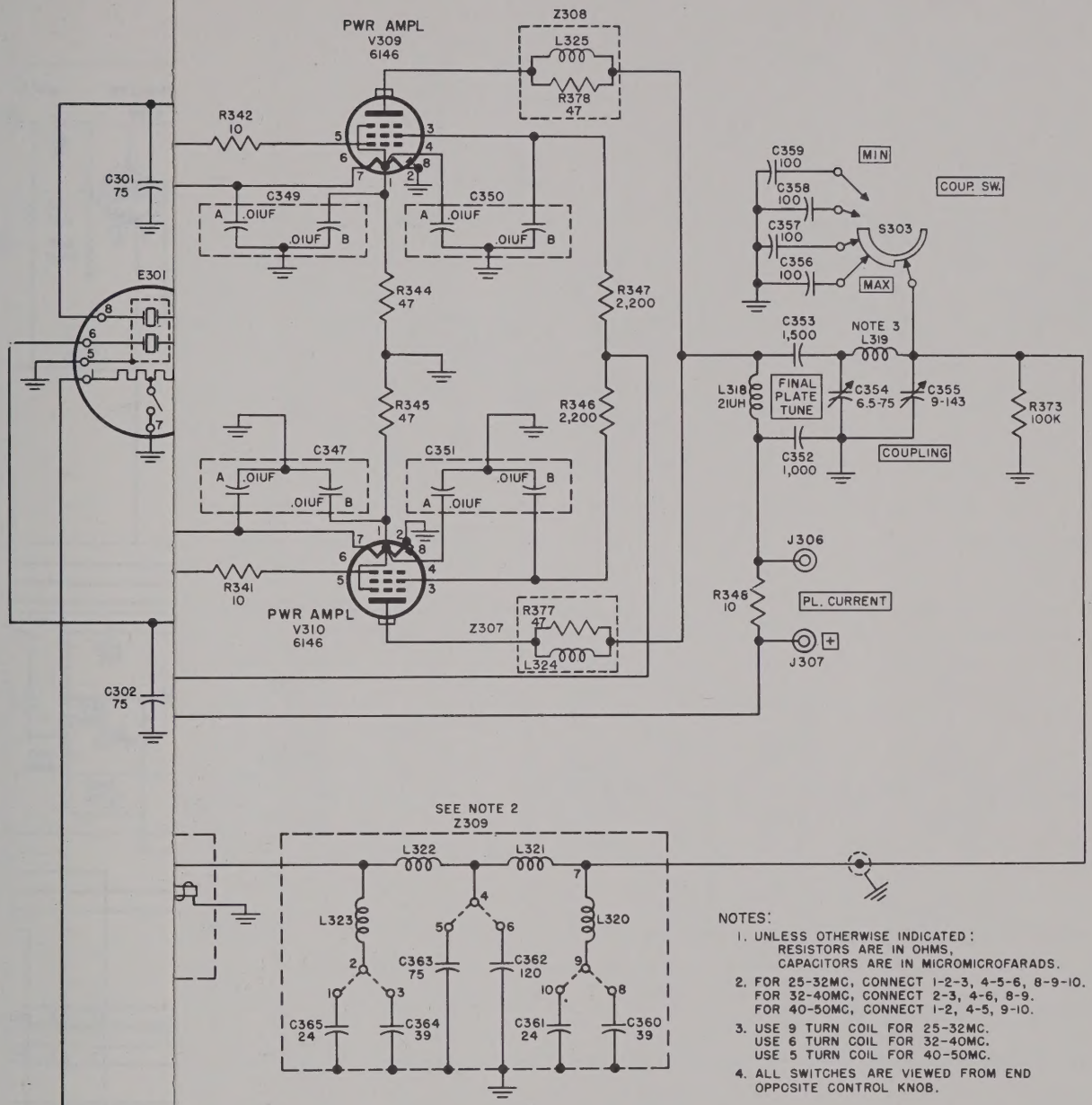
TM 226-562



NOTES:
1. ALL RESISTORS ARE IN OHMS.
2. COAXIAL CONNECTORS MARKED A1 AND A2 ARE LOCATED IN THE MAIN COMPONENT CONNECTORS AS SHOWN.
3. SWITCH S1906 SHOWN IN THE OFF POSITION.
4. SWITCH S1901 AND POWER CONNECTIONS TO RADIO SET CONTROL C-844/U NOT USED.
5. MAKE THE FOLLOWING JUMPER CONNECTIONS FOR RETRANSMISSION:
   TERMINAL 6 TO 7 ON TB1901
   TERMINAL 8 TO 10 ON TB1901
   TERMINAL 2 TO 3 ON TB1902.
6. FOR LOCAL OPERATION USING RECEIVER NO. 2 JUMPER TERMINAL 8 TO 9 ON TB1902.
7. WHEN USING RECEIVER NO. 1 JUMPER TERMINAL 3 TO 4 ON TB1905. WHEN USING RECEIVER NO. 2 JUMPER TERMINAL 4 TO 5 ON TB1905.

TM 226-582

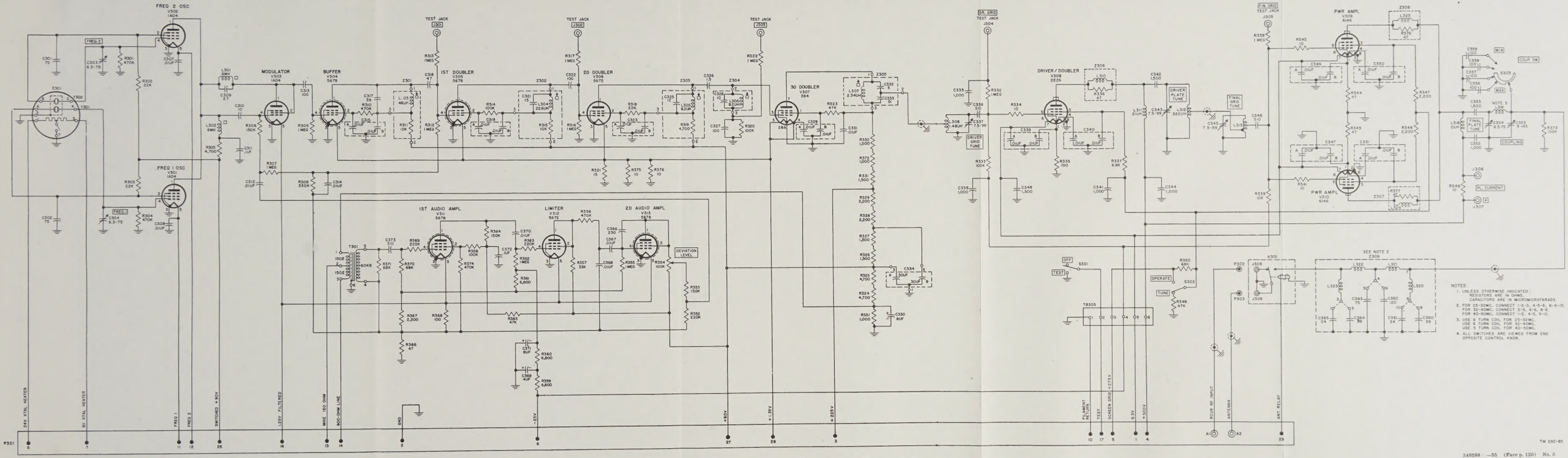
Figure 82. Electrical Equipment Cabinet CY-1221(*)/G, overall schematic diagram.



NOTES:

1. UNLESS OTHERWISE INDICATED:
   RESISTORS ARE IN OHMS,
   CAPACITORS ARE IN MICROMICROFARADS.
2. FOR 25-32MC, CONNECT 1-2-3, 4-5-6, 8-9-10.
   FOR 32-40MC, CONNECT 2-3, 4-6, 8-9.
   FOR 40-50MC, CONNECT 1-2, 4-5, 9-10.
3. USE 9 TURN COIL FOR 25-32MC.
   USE 6 TURN COIL FOR 32-40MC.
   USE 5 TURN COIL FOR 40-50MC.
4. ALL SWITCHES ARE VIEWED FROM END OPPOSITE CONTROL KNOB.

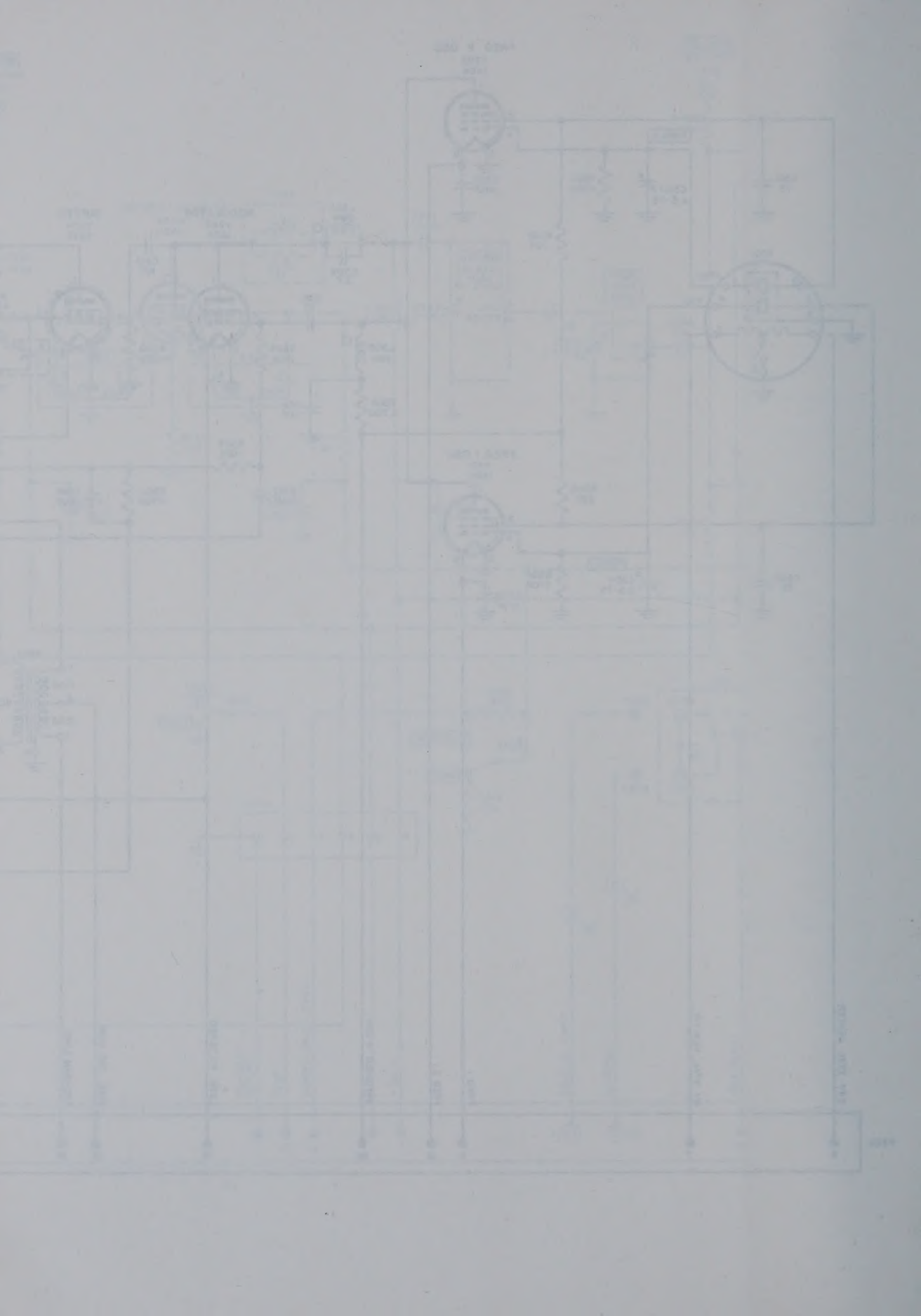
TM 282-85

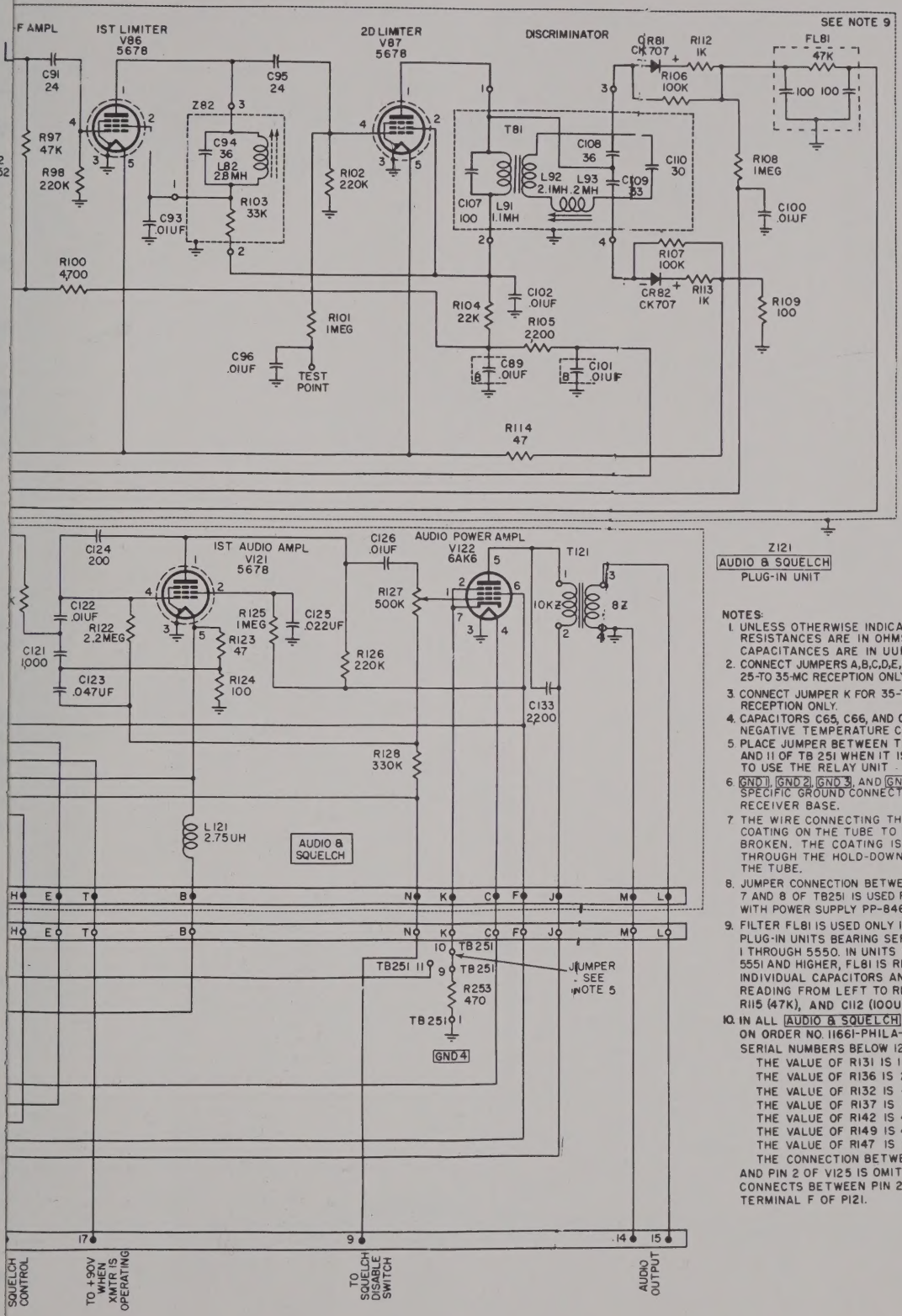


NOTES:
1. UNLESS OTHERWISE INDICATED:
   RESISTORS ARE IN OHMS.
   CAPACITORS ARE IN MICROMICROFARADS.
2. FOR 25-32MC, CONNECT 1-2-3, 4-5-6, 8-9-10.
   FOR 32-40MC, CONNECT 2-3, 4-6, 8-9.
   FOR 40-50MC, CONNECT 1-2, 4-5, 9-10.
3. USE 9 TURN COIL FOR 25-32MC.
   USE 6 TURN COIL FOR 32-40MC.
   USE 5 TURN COIL FOR 40-50MC.
4. ALL SWITCHES ARE VIEWED FROM END OPPOSITE CONTROL KNOB.

TM 282-85

Figure 83. Radio Transmitter T-417/GR, overall schematic diagram.



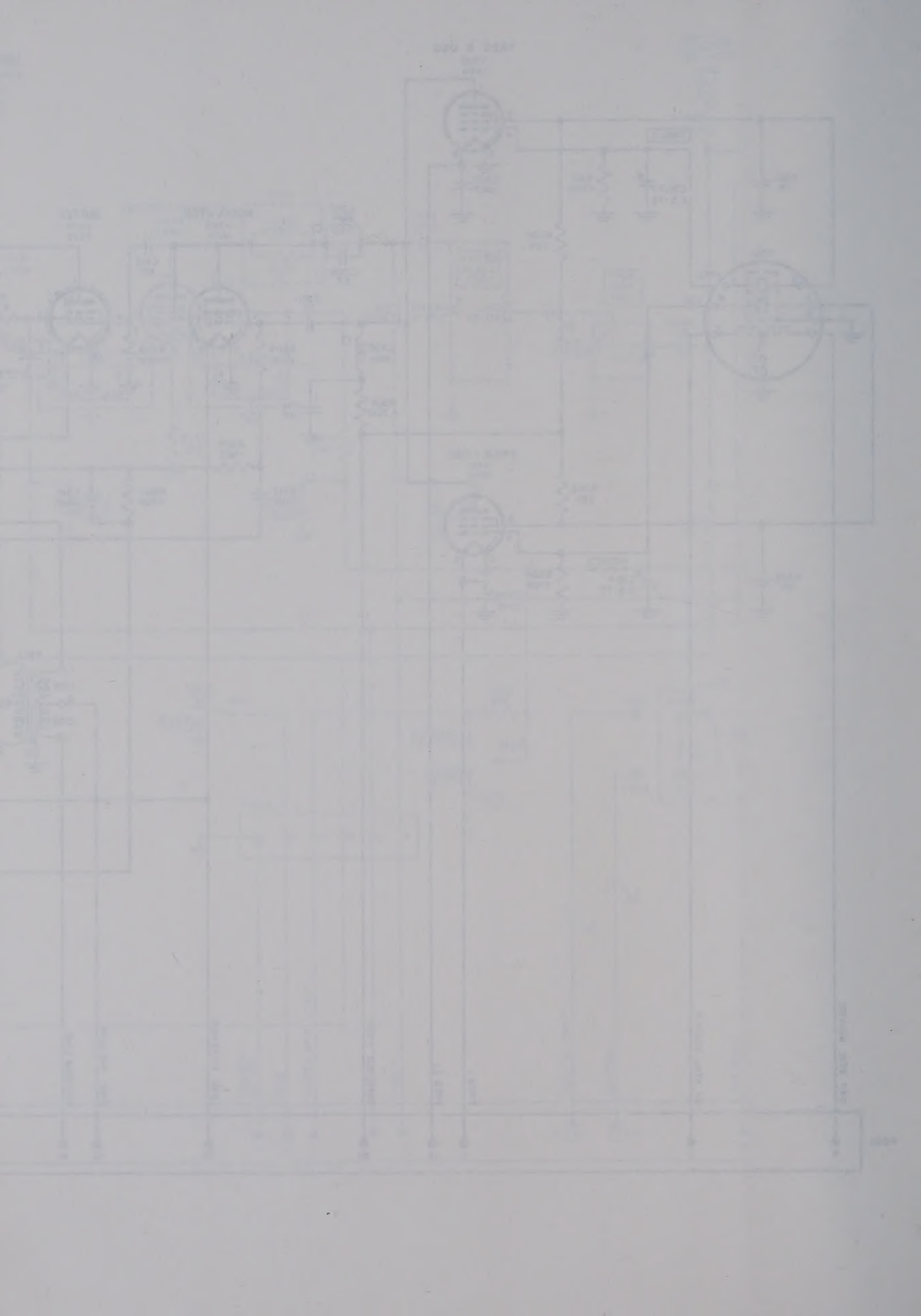


Z121
AUDIO & SQUELCH
PLUG-IN UNIT

NOTES:

1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF.
2. CONNECT JUMPERS A,B,C,D,E,F,G,H, AND J FOR 25-TO 35-MC RECEPTION ONLY.
3. CONNECT JUMPER K FOR 35-TO 50-MC RECEPTION ONLY.
4. CAPACITORS C65, C66, AND C67 HAVE A NEGATIVE TEMPERATURE COEFFICIENT.
5. PLACE JUMPER BETWEEN TERMINALS 10 AND 11 OF TB 251 WHEN IT IS DESIRABLE TO USE THE RELAY UNIT.
6. GND 1, GND 2, GND 3, AND GND 4 DENOTES SPECIFIC GROUND CONNECTIONS IN RECEIVER BASE.
7. THE WIRE CONNECTING THE OUTSIDE COATING ON THE TUBE TO PIN 3 MUST BE BROKEN. THE COATING IS GROUNDED THROUGH THE HOLD-DOWN CLAMP AROUND THE TUBE.
8. JUMPER CONNECTION BETWEEN TERMINALS 7 AND 8 OF TB251 IS USED FOR OPERATION WITH POWER SUPPLY PP-846/U.
9. FILTER FL81 IS USED ONLY IN 2ND IF DISCR PLUG-IN UNITS BEARING SERIAL NUMBERS 1 THROUGH 5550. IN UNITS SERIAL NUMBERED 5551 AND HIGHER, FL81 IS REPLACED BY INDIVIDUAL CAPACITORS AND A RESISTOR READING FROM LEFT TO RIGHT, C111(150 UUF) R115 (47K), AND C112 (100UUF).
10. IN ALL AUDIO & SQUELCH SUBASSEMBLIES ON ORDER NO. 11661-PHILA-52 BEARING SERIAL NUMBERS BELOW 1214:
    THE VALUE OF R131 IS 1MEG;
    THE VALUE OF R136 IS 220K;
    THE VALUE OF R132 IS 47K;
    THE VALUE OF R137 IS 470K;
    THE VALUE OF R142 IS 470K;
    THE VALUE OF R149 IS 470K; AND
    THE VALUE OF R147 IS 220K.
    THE CONNECTION BETWEEN PIN 2 OF V124 AND PIN 2 OF V125 IS OMITTED. R150 (680K) CONNECTS BETWEEN PIN 2 OF V125 AND TERMINAL F OF P121.

TM 5071-44



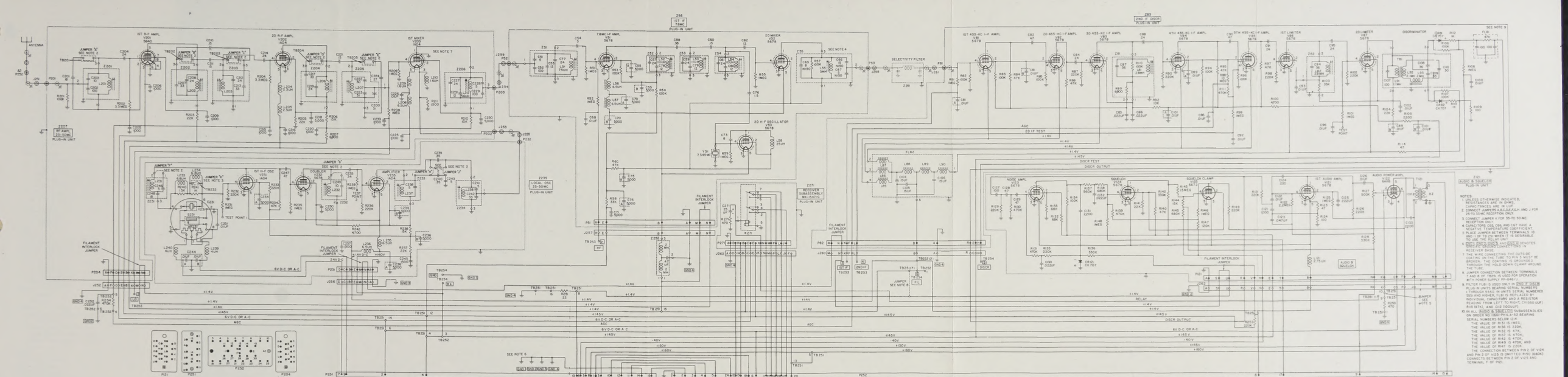
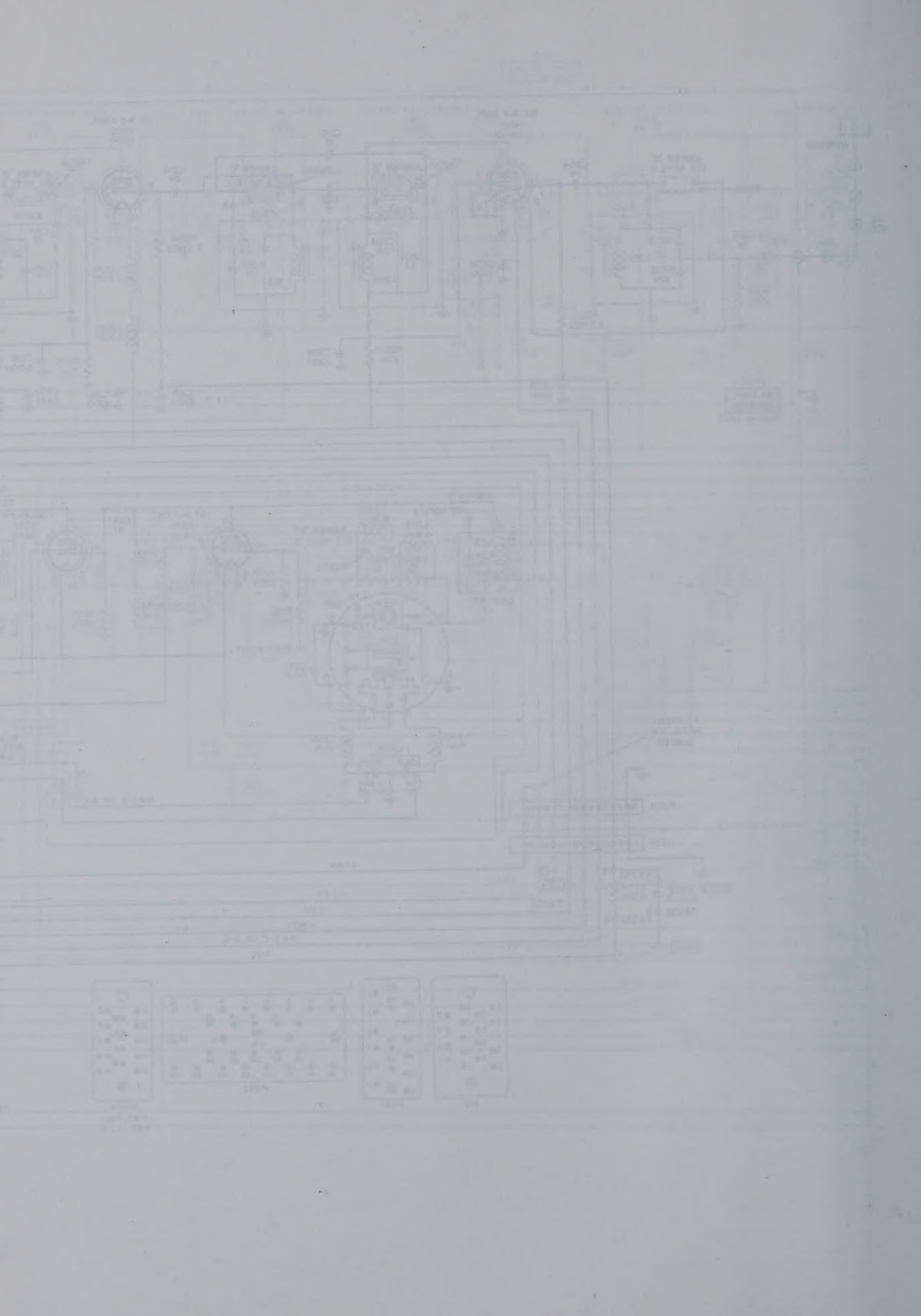


Figure 84. Radio Receiver R-257/U, overall schematic diagram.



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[AG 413.44 (27 Apr 55)]

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For explanation of abbreviations used, see SR 320–50–1.

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